



# Not all “caregivers” are created equal: Liking, caring and facial expression responses to the baby schema as a function of parenthood and testosterone

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## ABSTRACT

The baby schema elicits care from potential caregivers. However, much of the research on the baby schema is based on self-report only. To address this issue, we explored the effects of baby schema and child age on facial expressions (EMG) and eye-blink startle, in addition to self-reported liking and caring for 43 men and 48 women (39 parents). Further, basal testosterone was assessed. All groups responded with liking and caring to high baby schema, but only women also responded with more positive facial expressions. Caring and smiling towards infants compared to first graders depended on parenthood and testosterone levels. Basal testosterone levels were negatively associated with overall responsiveness to children in women and fathers, but positively in non-fathers. Whereas the baby schema overall lead to positive affect and caring, the scope of these responses and the processes underlying them depended on gender, parenthood and hormonal status.

## 1. Introduction

The cuteness of babies motivates adults to care for the helpless young. This caregiving response and the associated emotion of “tenderness” (Lishner, Batson, & Huss, 2011) or “nurturant love” (O’Neil, Danvers, & Shiota, 2018; Shiota et al., 2017) are not only elicited by related children, but also by unfamiliar – even out-group – children (Esposito et al., 2014; Golle, Probst, Mast, & Lobmaier, 2015; Hrdy, 2005). The first to investigate this phenomenon – the influential ethologist Konrad Lorenz – coined the term “baby schema,” i.e. specific stimulus attributes that trigger a caretaking response and the corresponding “complete affective attitude” (“Affektive Gesamteinstellung”; Lorenz, 1935). Indeed, the responses to the baby schema seem to be so deeply ingrained in human perceptual patterns that they even generalize to adults with babyish facial features (Deag & Crook, 1971; Zebrowitz & Montepare, 1992; Zebrowitz, 2003), animals (Archer & Monton, 2011; Fridlund & MacDonald, 1998; Golle, Lisibach, Mast, & Lobmaier, 2013; Lehmann, Huis in’t Veld, & Vingerhoets, 2013; Sanefuji, Ohgami, & Hashiya, 2007), and inanimate objects (Gould, 1979; Miesler, Leder, & Herrmann, 2011; Morris, Reddy, & Bunting, 1995). Because of this wide generalization of responses, the baby schema response is considered universal.

According to Lorenz, human faces with relatively large, low-lying eyes, small nose and mouth, a wide round face as well as a large,

prominent forehead correspond to the baby schema (Hückstedt, 1965; Lorenz, 1943). More recent research has largely confirmed these morphological correlates of cuteness, specifically forehead size and roundness of the face (Almanza-Sepúlveda et al., 2018). These features are typical for infants, but are also found in older children and even adults (Zebrowitz, 2006). The baby schema has been studied over many decades. However, the vast majority of studies on tenderness and caregiving have compared reactions to infants versus adults and did not explicitly focus on the baby schema. This limits their contribution to the understanding of baby schema effects per se as there are numerous influences on the social perception of adult faces that are unrelated to the baby schema, such as sexual attractiveness, but also traits not typically attributed to infants such as assertiveness or dominance (Collova, Sutherland, & Rhodes, 2019). Thus, that age can actually serve as a one-to-one proxy for the baby schema – as some authors have argued (Lehmann et al., 2013) – is questionable.

Studies that more explicitly focused on the baby schema most commonly used a correlational approach, measuring reactions to stimulus faces that naturally vary in baby schema, cuteness or attractiveness (e.g., Hildebrandt & Fitzgerald, 1978; Power, Hildebrandt, & Fitzgerald, 1982; Schein & Langlois, 2015). This correlational approach is problematic for two reasons. First, pictures of different children naturally vary in regard to other factors as well, which in infants are often impossible to control for. These include, for example, differences in

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facial expressions and hair style, which are known to influence social perception (Hess, Adams, & Kleck, 2004). Secondly, naturally occurring differences in facial proportions are related to other variables like prenatal testosterone levels (Whitehouse et al., 2015), premature birth (Maier, Holmes, Slaymaker, & Reich, 1984), as well as actual and perceived health (Henderson, Holzleitner, Talamas, & Perrett, 2016; Volk, Lukjanczuk, & Quinsey, 2005). Thus, studies that use a correlational approach have limited generalizability.

Experimental studies that manipulated baby schema features in stimuli systematically used, for the most part, schematic drawings (e.g., Alley et al., 1981; Hückstедt, 1965; Sternglanz, Gray, & Murakami, 1977), which have only limited ecological validity. In recent years, however, there has been renewed interest in the baby schema, starting with Glocker et al. (2009), who were first to use modern image morphing techniques to experimentally manipulate facial features in photos of children, thus creating a more ecologically valid paradigm to study baby schema effects. Several studies have since utilized similar approaches to further the understanding of the baby schema (e.g., Borgi, Cogliati-Dezza, Brelsford, Meints, & Cirulli, 2014; Hahn, DeBruine, Fisher, & Jones, 2015; Hahn, DeBruine, & Jones, 2015; Holtfrerich, Pfister, Gammal, Bellon, & Diekhof, 2018; Komori & Nittono, 2013; Little, 2012; Lobmaier, Sprengelmeyer, Wiffen, & Perrett, 2010; Sprengelmeyer et al., 2009). In sum, although the baby schema has been studied for more than 80 years, only in recent years have modern image manipulation capabilities enabled a more thorough and ecologically valid research approach. The present study aims to investigate the effects of manipulated baby-facedness in infants and school children on self-reports of caretaking intentions as well as on psychophysiological responses and affective evaluations.

### 1.1. Universal responses to the baby schema

A number of extensive reviews exist on specific aspects of the baby-schema, including effects of infantile features on social perception (Franklin & Volk, 2018; Zebrowitz, 1997) and attention (Lucion et al., 2017), neuropsychological and neuroendocrinological perspectives on cuteness and caretaking (Bos, 2017; Hahn & Perrett, 2014; Kringsbach, Stark, Alexander, Bornstein, & Stein, 2016; Luo et al., 2015; Rilling, 2013), the emotional components of the corresponding emotion of nurturant love (O'Neil et al., 2018) as well as the associated Japanese concept of "kawaii" (Nittono, 2016). For the sake of brevity, we limit our exposition of past research to variables that are central to the present study.

In terms of self-report, there is consistent evidence that baby-faced infants are perceived as cute and elicit caretaking motivation (e.g., Glocker et al., 2009; Hückstедt, 1965; Komori & Nittono, 2013; Little, 2012; McKelvie, 1993; Stavropoulos & Alba, 2018; Sternglanz et al., 1977). Indeed, the connection of baby-facedness and perceived cuteness is so strong that the terms have been used interchangeably in the literature (e.g., Sherman, Haidt, Iyer, & Coan, 2012). On the behavioral level, baby-facedness invites active social approach as indexed by increased key-presses to prolong viewing times (Parsons, Young, Kumari, Stein, & Kringsbach, 2011; Sprengelmeyer, Lewis, Hahn, & Perrett, 2013).

Baby schema effects on mood have, to our knowledge, not been studied. However, in some studies participants reported more positive mood, especially feelings of tenderness, after viewing pictures of infants (without explicit control of baby-facedness) compared to adults (Sherman, Haidt, & Coan, 2009; Shiota, Neufeld, Yeung, Moser, & Perea, 2011).

By contrast, results based on psychophysiological measures have been less univocal. Facial expressions of emotions are central to human interaction (Niedenthal & Brauer, 2012), especially in response to pre-verbal infants (e.g., Nicely, Tamis-LeMonda, & Bornstein, 1999). Furthermore, parents' nonverbal communication of positive emotions, particularly smiling at children, is essential for optimal child

development (e.g., Eisenberg et al., 2001; Zhou et al., 2002). In line with observational studies (e.g., Schleidt, Schiefenhövel, Stanjek, & Krell, 1980), more smiling and less frowning towards infants than towards other images has also been shown with electromyographic measures (Hildebrandt & Fitzgerald, 1978; Nittono & Ihara, 2017; Spangler, Emlinger, Meinhardt, & Hamm, 2001). Comparisons of infants differing in perceived cuteness, however, resulted in null or mixed findings (Hildebrandt & Fitzgerald, 1978; Power et al., 1982; Schein & Langlois, 2015). Facial expressions beyond smiling and frowning have, to our knowledge, not been studied in connection with the baby schema. Of particular interest in this context would be "sneering," i.e. the facial expression of disgust. From a theoretical, moral psychology perspective, Sherman and Haidt (2011) postulate the "cuteness response" to be antagonistic to disgust. Additionally, muscles involved in disgust expressions have been shown to respond to ugliness and attractiveness (e.g., Principe & Langlois, 2010; Schein & Langlois, 2015), concepts closely related to cuteness in babies (Zebrowitz & Montepare, 1992).

Even more inconclusive is the state of evidence regarding other peripheral physiological measures. Electrodermal measures are among the most widely used methods in psychophysiology (Boucsein, 2012, p. xi). The amplitude of skin conductance responses has been shown to be sensitive to arousal independent of valence, emotional intensity of individual stimuli as well as the allocation of attention and the strength of orienting responses (Frith & Allen, 1983; Lang, Greenwald, Bradley, & Hamm, 1993; Traxel, 1960; for a review see Boucsein, 2012). In the context of the baby schema, some studies have predicted and found increased skin conductance responses associated with infants or infant attractiveness (Shiota et al., 2011), whereas others did not (e.g., Hildebrandt & Fitzgerald, 1978; Nittono & Ihara, 2017). In terms of general autonomic activation, tenderness and cuteness have been associated with both increased and decreased sympathetic activity as measured by heart rate and skin conductance levels (Bloch, Orthous, & Santibanez-H, 1987; Sherman et al., 2009; Shiota et al., 2017).

Further well-established psychophysiological paradigms of emotion like the acoustic startle response (Vrana, Spence, & Lang, 1988) or the post-auricular reflex (Benning, Patrick, & Lang, 2004) have not been employed in connection with baby-facedness to date. In general, the eye-blink startle is amplified during exposure to aversive or threatening stimuli and attenuated during exposure to positive stimuli (Lang, Bradley, & Cuthbert, 1990). In one study, Spangler et al. (2001) found reduced eye-blink startle responses while viewing infants compared to other neutral and negative pictures in a between-subject design but not in a within-subject design. The post-auricular reflex, by contrast, is sensitive to appetitive stimuli. For example, in the context of care eliciting stimuli some studies have found increased post-auricular reflex associated with nurture-related stimuli (for a review see Benning, 2018). Both, the eye-blink startle and the post-auricular reflex, have to date not been studied in response to the baby schema.

In summary, it is relatively well-established that the baby schema leads to positive stimulus evaluations, social approach and caretaking motivation. By contrast, research on facial expressions, specifically smiling responses, has been inconclusive. Concerning the physiological reactions to the baby schema, results have also been inconsistent (e.g., skin conductance, heart rate) or non-existent (reflex modulation). Finally, whether the baby schema impacts more lasting mood states beyond the immediate responses to stimuli is also an open question. The present research aims to address this gap in the literature by incorporating multiple measures in one design: Explicit stimulus evaluations, self-report measures of caretaking motivation and mood, facial EMG, SCR, and acoustic startle responses.

### 1.2. Interindividual differences in responses to the baby schema

A number of individual differences can be expected to influence responsiveness to infants. Here, we will focus on sex, parenthood and hormonal status. In regard to sex differences, women seem to be overall

more sensitive and responsive to the baby schema than men (Glocker et al., 2009; Hahn, Xiao, Sprengelmeyer, & Perrett, 2013; Lobmaier et al., 2010; Sherman et al., 2012; Sprengelmeyer et al., 2009). Yet, even though women consistently show larger preferences for infants in self-report measures, behavioral studies on sex differences have yielded inconsistent results (Berman, 1980; Hahn et al., 2013; Maestripieri & Pelka, 2002; Parsons et al., 2011; Sprengelmeyer et al., 2013). This suggests the influence of additional person characteristics.

One major factor influencing people's attitude towards infants is parenthood. A substantial body of research has shown the fundamental neuropsychological impact that parenthood has on men and to an even larger extent on women (Barrett & Fleming, 2011; Duarte-Guterman, Leuner, & Galea, 2019; Feldman, Braun, & Champagne, 2019; Leuner, Glasper, & Gould, 2010; Rajhans, Goin-Kochel, Strathearn, & Kim, 2019; Rilling & Mascaro, 2017; Zilkha, Scott, & Kimchi, 2017). In terms of responsiveness to infantile stimuli, early studies (Feldman & Nash, 1978; Nash & Feldman, 1980) found that mothers are more interested in infants than non-mothers; fathers, however, did not differ from non-fathers. More recent experimental studies have, for example, shown increased attention to infants in parents (Thompson-Booth et al., 2014b; Oliveira et al., 2017; Thompson-Booth et al., 2014a; Weisman, Feldman, & Goldstein, 2012) as well as a greater preference for infants versus adults or scenery in terms of explicit ratings (Dudin et al., 2019; Lehmann et al., 2013). In contrast, Senese et al. (2013) found no influence of parenthood on implicit positive affect towards infants. However, none of these studies did explicitly vary the baby-facedness of the stimuli.

Finally, as a communally living species, caring for the young is neurologically and biochemically rooted in humanity's evolutionary past (for reviews see Numan & Insel, 2003; Panksepp, 1998). Hence, the hormonal basis of adults' reactivity to infants is an ongoing research topic (for a review see Bos, 2017). One prominent candidate, especially in connection with paternal behavior, is testosterone. The "challenge hypothesis" (Wingfield, Hegner, Dufty, & Ball, 1990) implicates testosterone in mediating a trade-off between mating and paternal efforts (for a review see Gray, Straftis, Bird, McHale, & Zilioli, 2019). Accordingly, stable relationships and fatherhood have been associated with a decrease in testosterone levels in men (for reviews see Gray, McHale, & Carré, 2015; Grebe, Sarafin, Strenth, & Zilioli, 2019). Low testosterone levels have also been connected to increased paternal responsiveness to infants and better quality of paternal care (e.g., Gettler, Lew-Levy, Sarma, Miegakanda, & Boyette, 2020; Kuo et al., 2018; Mascaro, Hackett, & Rilling, 2013; Mascaro, Hackett, & Rilling, 2014; Storey, Noseworthy, Delahunty, Halfyard, & McKay, 2011; Weisman, Zagoory-Sharon, & Feldman, 2014; for reviews see Gettler, 2020; Meijer, Ijzendoorn, & Bakermans, 2019). Thus, testosterone has been generally assumed to be antagonistic to paternal care (e.g., Rilling & Mascaro, 2017; Storey & Ziegler, 2015). However, whether the role of testosterone in paternal care is that universal and straightforward is still debated (e.g., Marler, Bester-Meredith, & Trainor, 2003; Van Anders, 2013). For example, studies exploring men's testosterone reactivity to infant cries point to a variable and context-dependent role of testosterone (Fleming, Corter, Stallings, & Steiner, 2002; Roellke, Raiss, King, Lytel-Sternberg, & Zeifman, 2019; Van Anders, Tolman, & Volling, 2012; for a review see Zilioli & Bird, 2017). In several studies, passively listening to infant cries lead to an increase in men's testosterone levels (e.g., Fleming et al., 2002; Van Anders et al., 2012). By contrast, given the opportunity to sooth the crying infant in an infant doll paradigm, listening to baby cries was generally associated with decreases in testosterone levels (Van Anders et al., 2012). In a recent study with an infant doll, Roellke et al. (2019) showed that 'testosterone-decreasers' provide higher quality care than 'testosterone increasers.' Taken together, although high testosterone seems to be generally antagonistic to nurturing behavior in men, it can also increase caring, for example in terms of infant defense (for a review see Van Anders, 2013). However, to our knowledge, no study has looked at the connection between testosterone and baby schema effects in men.

Research on testosterone in women is sparse and more inconsistent. On a general level, testosterone in women was shown to be negatively associated with femininity and gendered behavior, including interest in babies (e.g., Baucom, Besch, & Callahan, 1985; Udry, 2000; Udry, Morris, & Kovenock, 1995). As in men, low testosterone has been associated with parenthood (e.g., Barrett et al., 2013; Kuzawa, Gettler, Huang, & McDade, 2010) and, less consistently, with being partnered (Van Anders & Goldey, 2010; Van Anders & Watson, 2006b). Moreover, caregiving towards a crying infant doll was associated with a decrease in women's testosterone levels as well (Voorthuis, Bakermans-Kranenburg, & van IJzendoorn, 2017). On the other hand, high evening testosterone levels in mothers have been associated with increased sensitivity to their children (Endendijk et al., 2016) and testosterone administration has been shown to upregulate maternal care in terms of neuronal responses to infant cries (Bos, Hermans, Montoya, Ramsey, & van Honk, 2010). Three studies have examined the influence of testosterone on baby schema effects. In one study, high salivary testosterone levels were associated with slower allocation of attention to infant faces among adult distractors, whereas testosterone was not associated with different responses in regard to baby schema manipulations (Holtfrerich, Schwarz, Sprenger, Reimers, & Diekhof, 2018). In a second study, focusing on intra-individual variations of testosterone levels, high testosterone was associated with an increased reward value of the baby schema in a behavioral task, but not with increased liking in terms of explicit ratings (Hahn, DeBruine, Fisher, 2015; Hahn, DeBruine, 2015). In a third study, testosterone levels did not have any effect on performance in a cuteness discrimination task (Lobmaier, Probst, Perrett, & Heinrichs, 2015).

In sum, women, especially mothers, are more responsive to the baby schema than men, at least in explicit measures. Parenthood, although leading to increased attention towards infant stimuli, does not necessarily entrain more positive affective evaluations. And finally, whereas high basal testosterone levels are generally associated with reduced responsiveness to infantile stimuli for men, the influence of testosterone on care in women and its role in baby schema effects remains unclear. The present research addresses these questions by including participants' sex and parenthood as factors into the design as well as basal testosterone levels as a moderator.

### 1.3. Aims and hypotheses of the current study

In all, the current state of evidence concerning the emotional and physiological profile of nurturant love in general and the baby schema as prime elicitor in specific is still limited at best (Shiota et al., 2017). As mentioned above, extant research has several methodological limitations and is mainly focused on a limited number of discrete outcome variables.

The aim of the present research is to address several open questions in human baby schema research by using a multivariate approach including different emotion components (subjective experience, nonverbal expression and physiological responses) as well as person characteristics (sex, parenthood, basal testosterone levels) as possible moderators. Consistent with our experimental methodology, we systematically varied the baby schema in faces of infants and first graders in addition to a correlational approach of comparing responses to these two age groups.

In line with previous research, we expected the baby schema to lead to more liking and positive emotions as well as higher caring in both men and women. Further, higher baby schema should be associated with more positive facial expressions and increased skin conductance responses as well as with startle inhibition.

Following extant literature, we cautiously predicted that child age effects, i.e. responses to infants versus first graders, by and large parallel the baby schema effects mentioned above. We expected child age effects on psychophysiological measures to be stronger than baby schema effects as they represent a less subtle contrast.

In terms of the moderating influence of person characteristics, we expected a larger influence of parenthood on women, due to the stronger social and biological effects of becoming a mother compared to fatherhood. Further, we expected higher testosterone levels to be associated with reduced caring for men, but not necessarily for women.

## 2. Methods

### 2.1. Participants

The final sample consisted of 91 German adults, 48 women (20 mothers) and 43 men (19 fathers). Mothers and fathers were not parents of joined children.

One man was excluded from our analyses due to extremely high testosterone levels and one man was excluded because he was older than our cut-off. Other exclusions, due to missing data or disproportionate statistical influence (see section on data analysis), were handled separately for each dependent variable (for number of excluded participants see supplementary material, Table S1 and S2 for men and women respectively). Participants were paid 12€. Sample size was calculated using a web-tool for power analysis with random targets and participants (Judd, Westfall, & Kenny, 2017). To achieve 80 % power with 48 targets a sample size of 19 participants per independent group would be needed. All procedures were approved by the institutional ethics board of the department of psychology at Humboldt University of Berlin.

#### 2.1.1. Demographics

Participants were between 21 and 45 years old ( $M = 31.00$ ,  $SD = 5.13$ ). The age range was expanded from our original plan to facilitate recruitment of parents. Accordingly, parents in our sample were significantly older than the non-parents ( $M_{\text{Non-Mothers}} = 27.50$ ,  $SD = 3.53$ ,  $M_{\text{Mothers}} = 32.50$ ,  $SD = 4.48$ ,  $t(1,46) = -4.32$ ,  $p < .001$ ;  $M_{\text{Non-Fathers}} = 30.79$ ,  $SD = 4.37$ ,  $M_{\text{Fathers}} = 34.84$ ,  $SD = 5.46$ ,  $t(1,41) = -2.70$ ,  $p = .010$ ). The age of their first child was similar for mothers and fathers ( $M_{\text{Mothers}} = 6.79$ ,  $SD = 5.55$ ;  $M_{\text{Fathers}} = 5.85$ ,  $SD = 4.21$ ,  $t(1,36) = 0.56$ ,  $p = .562$ ). Including age as a covariate in the analyses did not alter the results, except in the case of women's positive mood (see supplementary material).

### 2.2. Experimental design

We used a 2 (baby schema) x 2 (child age) within-subject design with participant sex and parenthood as between-subject factors. Every participant viewed high and low baby schema infants and first graders in four separate blocks. Block order was counter-balanced over participants, image order within blocks was randomized for each participant.

### 2.3. Stimulus material

High baby schema and low baby schema versions (see Fig. 1) of the same grayscale portrait photographs of 12 infants (6 female, ca. 12 months old) and 12 first graders (6 female, ca. 6 years old; from "CAFE" set; LoBue & Thrasher, 2015) were created following a widely-used procedure, first described by Glocker et al. (2009). First, we measured facial landmarks using a modified version of Face-Substitution-Editor (Castro & McDonald, 2011). Using Adobe Photoshop, we morphed the faces to arrive at high baby schema versions (larger eyes, smaller nose and mouth, increased face width, increased forehead size) and low baby schema versions (smaller eyes, larger nose and mouth, reduced face width, reduced forehead size) of the same child. Morphing was limited to 2 standard deviations of the means of the original faces to preserve a natural appearance of the final stimuli. For the use of the images for research purposes, we obtained parental permission as well as ethics approval.

### 2.4. Salivary testosterone

To assess interindividual differences in basal testosterone levels, participants supplied one 2 ml passive drool saliva sample after 10–15 minutes of calm activity at the beginning of the experiment (e.g. reading consent forms). Participants were asked to refrain from eating and drinking one hour before the experiment and rinsed their mouth with cold water a few minutes before giving the saliva sample. Due to diurnal variation of testosterone (Granger, Shirtcliff, Booth, Kivlighan, & Schwartz, 2004), all experimental sessions took place in the afternoon (2 pm, 4 pm). Saliva samples were frozen at  $-20^{\circ}\text{C}$  immediately after collection until they were shipped on dry ice to the biopsychology lab at Technical University Dresden for analysis. Luminescence immuno-assays were carried out using commercially available test kits (Testosterone Luminescence Immunoassay, IBL International, RE62031). The sensitivity for the assay is 1.8 pg/ml and inter- and intra-assay variances for concentrations in the normal range are below 6 %. To achieve normality of the distribution, testosterone levels were log-transformed.

### 2.5. Dependent measures

#### 2.5.1. Stimulus evaluations

Participants rated each image on seven-point scales in terms of pleasantness, cuteness, annoyance, need for protection and caretaking motivation from "0" = "not at all" to "6" = "very much" and arousal/calmness from "-3" = "very calming" to "+3" = "very arousing." A principal component analysis that explained 72 % of the variance revealed two factors: Liking (pleasant, cute, annoying(reversed), arousing(reversed)) and caring (need for protection, caretaking motivation). We calculated scale means based on this analysis.

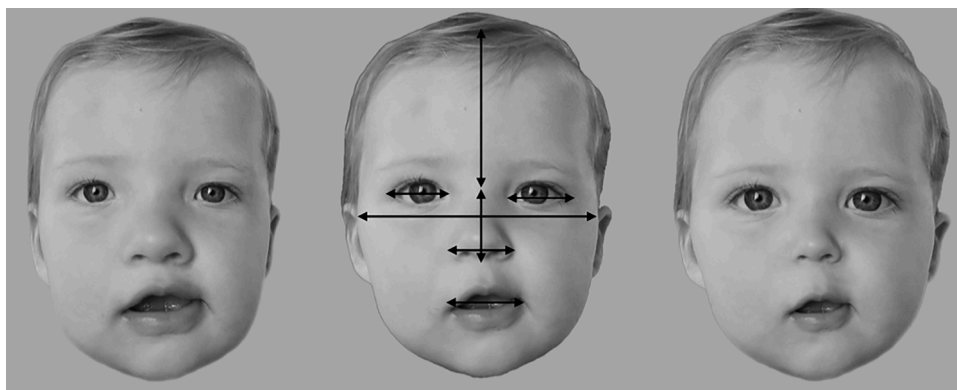
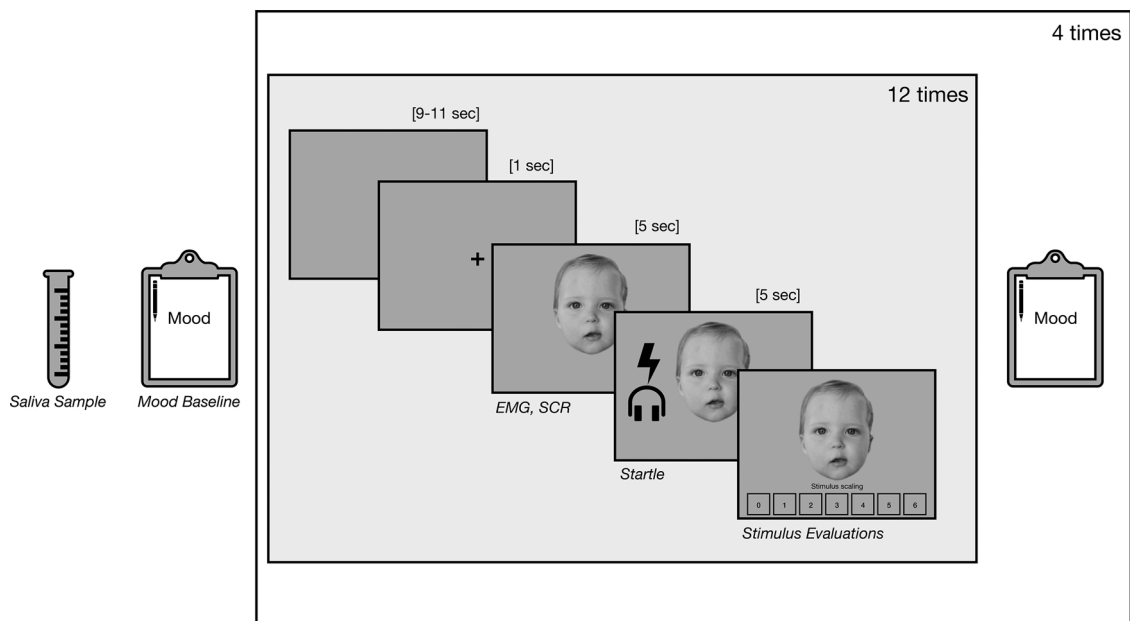


Fig. 1. Low baby schema (left) and high baby schema (right) versions of the same infant (middle). Arrows indicate the manipulated facial features.



**Fig. 2.** Experimental procedure. Each of the 4 blocks (white frame; low baby schema vs. high baby schema, infants vs. first graders) consisted of 12 trials (gray frame) and one mood measurement.

### 2.5.2. Facial EMG

We recorded facial expressions in response to the stimuli using facial EMG during the first three seconds after stimulus onset. The second before stimulus onset during presentation of the fixation cross was used as baseline.

Bipolar EasyCAP Ag/AgCl miniature surface electrodes filled with Signa Gel by Parker Laboratories Inc. (Fairfield, NJ) were placed on the left side of the face at following sites: M. zygomaticus major (Zyg; lifting corner of the mouth, smiling), lateral M. orbicularis oculi (Occ; wrinkling eyes, smiling), M. levator labii superioris alaeque nasi (Lev; lifting upper lip, disgust, sneering) and M. corrugator supercilii (Cor; wrinkling eyebrows, frowning). The skin was cleaned using lemon prep peeling and 70 % alcohol. All signals were recorded using MindWare bioamplifiers (Gahanna, OH) with a 50 Hz notch filter at 1000 Hz. EMG was bandpass filtered between 30 and 300 Hz. EMG data were offline rectified and smoothed.

Video recordings for each trial were inspected for movements (e.g. yawning, coughing) that could interfere with EMG measures. Corresponding data were excluded. To control for interindividual differences in muscle tension, we calculated difference from baseline for each reaction and z-transformed difference scores within participant and muscle.

To reduce the number of variables, smiling responses were operationalized as the contrast score between muscles involved with smiling (Zyg, Occ) and the muscle involved with frowning (Cor) following Hess et al. (2017). Sneering was operationalized as Levator activity. As inspection of the data indicated Zygomaticus cross-talk in Levator measurements, which is a well-known phenomenon (Vrana, 1993), we included Zygomaticus activity as a covariate in our model for Levator activity.

### 2.5.3. Acoustic startle responses (ASR)

We recorded responses to 95 dB white noise bursts with above described materials below the left eye on M. orbicularis oculi. Acoustic probes were played over beyerdynamic DT-990-pro headphones. Two startle probes were presented during the practice trials, one during a picture and one during the inter-trial interval. During the main experiment, ten startle probes were presented in each block. Of these ten probes, the seven critical probes were presented simultaneously with a picture on random occasions from 5 to 7 seconds after stimulus onset. To

reduce predictability, three additional startle probes were presented during the inter-trial interval, 2–4 seconds after stimulus offset, and during two trials no startle probe was presented.

Startle responses for each trial were defined as a peak of 2 standard deviations over baseline in a window of 20–150 ms after the startle probe minus the mean 50 ms pre-probe baseline. Eight participants were excluded from the analysis for being non-responders or because of technical problems. Singular trials with null-responses, excessive noise or voluntary eye blinks 50 ms before to 150 ms after the startle probe were excluded from the analysis. To facilitate interpretation of possible between- and within-subject interactions, ASRs were within-subject zstandardized (Blumenthal et al., 2005) including ASRs during the inter-trial-interval.

In addition to eye blink startle responses, we also measured post-auricular reflexes to the acoustic probes. Due to technical problems, however, post-auricular reflexes could not be analyzed.

### 2.5.4. Skin conductance responses (SCR)

As a physiological measure of emotional intensity, skin conductance responses to the stimuli were measured. However, skin conductance responses habituated quickly, possibly due to the block-wise presentation. The resulting small number of SCRs – on average 8 for women and 13 for men – severely limits the interpretability of the results. For that reason, detailed methodology and results for SCRs will only be described in the supplementary materials.

### 2.5.5. Mood

To assess positive and negative mood after each block, we used a 14-item mood checklist (shortened and modified version of Mood Checklist BSKE (“Mood scaling by categories and adjectives”); Janke, Hüppe, & Erdmann, 2002). After each block, participants rated how they felt in the moment in terms of adjectives on seven-point scales from “0” = “not at all” to “6” = “very strongly”. Items were combined into two broad categories: Positive Mood (happy, confident, sociable, tender, caring, active, relaxed) and Negative Mood (anxious, despondent, sad, angry, aggressive, inwardly excited). One item (“sexually aroused”) was

excluded from the analysis, because it did not fit into the categories.

Mood ratings for each block were calculated as difference scores to the pre-experiment baseline. Five participants failed to complete the baseline questionnaire. Their baseline values were substituted by the group mean.

In the main text, we will only report highlights of the mood results. More detailed results can be found in the supplementary materials.

## 2.6. Procedure

Upon arrival at the laboratory, participants were informed about the experiment, read and signed the consent forms, and gave a saliva sample. Then electrodes were placed for facial EMG and EDR and a test measurement was made. Participants completed two practice trials to acquaint themselves with the experimental procedure. The experiment consisted of four blocks, one for each image category, with 12 trials each (see Fig. 2). After each block, participants completed the mood questionnaire. For each trial, participants saw a fixation cross for 1 second, followed by the image for 10 seconds. Participants were instructed to passively view each image. During the first 5 seconds, physiological responses to the image (Facial EMG, SCR) were recorded and in the last 5 seconds startle probes were presented. Afterwards, the scales for the stimulus ratings were presented below the image, one after the other. Between the last rating and the next fixation cross was a varying inter-stimulus interval with a blank screen (9–11 seconds).

## 2.7. Data analysis

All stimulus-dependent data (ratings, SCR, EMG, ASR) were analyzed with R (R Core Team, 2019) using linear mixed models with crossed random effects of participant and target child (Baayen, Davidson, & Bates, 2008) with restricted Maximum Likelihood estimations using the R-package "lme4" (v. 1.1–21; Bates, Kliegl, Vasishth, & Baayen, 2015; Bates, Mächler, Bolker, & Walker, 2015). The fixed effects structure was predetermined by the experimental design (i.e., main effects of baby schema, child age, parenthood, testosterone, and their interactions). Because of the differences in mean testosterone levels and range between men and women, we analyzed data for men and women separately (c.f. Granger et al., 2004). Finally, as mentioned above, zygomaticus major activity was included as a covariate in the model for sneering to account for cross-talk.

Following current recommendations, we started with the maximal random effects structure (Barr, 2013) and then backwards eliminated random slopes using likelihood-ratio tests with a conservative  $p = .10$  threshold to arrive at a converging, parsimonious random effects structure for each analysis (Bates, Kliegl et al., 2015; Bates, Mächler et al., 2015; Matuschek, Kliegl, Vasishth, Baayen, & Bates, 2017). Testosterone levels were log-transformed and centered and included in the models as continuous predictors; baby schema, child age, participant sex, and parenthood were contrast-coded and included as categorical predictors. Models for mood ratings were estimated using only random effects of participant, which is equivalent to an ANOVA approach.

Influential cases (i.e. outliers with a disproportionate statistical influence on results) were detected using the R-package "influence.ME" (Nieuwenhuis, Te Grotenhuis, & Pelzer, 2012). Cases with a Cook's distance larger than  $4/n$  (Fox, 1991) were excluded. Significance was determined by calculating 95 % confidence intervals using a parametric percentile bootstrap method with 5000 simulations. Estimated marginal means were calculated with the emmeans-package (Lenth, 2017) and used for figures and post-hoc z-tests.

## 3. Results

### 3.1. Initial analysis

Basal testosterone levels of participants were assessed from saliva

samples provided at the beginning of the experiment. The detailed procedure is described below. Mean testosterone levels of the final sample were 66.16 pg/ml ( $SD = 28.00$ ) for men and 14.63 pg/ml ( $SD = 9.00$ ) for women. Additional data and analysis of baseline testosterone levels can be found in the supplementary materials.

Below, we first report the results for men and then for women. A rough overview of the main results is presented in Table 1. Detailed results of the analysis can be found in the supplementary materials. For men, detailed results of the analysis can be found in Table S1, descriptive data for groups and conditions in Table S3. For women, detailed results of the analysis can be found in Table S2, descriptive data for groups and conditions in Table S4.

### 3.2. Men

#### 3.2.1. Stimulus evaluations

Significant effects of the baby schema on liking and caring emerged, but no main effects of child age. Additionally, a significant parenthood by testosterone interaction on liking as well as a significant child age by parenthood interaction on caring emerged.

As Fig. 3 shows, men reported higher liking and overall caring for high baby schema children (liking:  $z = 7.72, p < .001$ ; caring:  $z = 2.80, p < .005$ ). They did, however, not report higher liking for infants compared to first graders ( $z = 0.11, p = .916$ ). Only non-fathers reported higher caring for infants than for first graders (non-fathers:  $z = -2.52, p = .012$ ; fathers:  $z = -0.74, p = .459$ ). Paired comparisons to unpack the parenthood by testosterone interaction on liking did not show significant effects. Higher testosterone levels were associated with marginally increased liking in non-fathers ( $z = -1.73, p = .083$ ), but with descriptively less liking in fathers ( $z = 1.09, p = .278$ ).

#### 3.2.2. Facial expression responses

A significant child age by testosterone interaction on smiling responses emerged. There were no significant effects on sneering.

Although the baby schema proper had no effect on facial expressions, men smiled more at infants compared to first graders. As Fig. 4 shows, this effect was more pronounced in men with higher testosterone levels.

#### 3.2.3. Eye blink startle

No significant main effects or interactions on startle responses emerged.

#### 3.2.4. Mood

Viewing high baby schema images lead to increased positive mood for all men. Additionally, for non-fathers, low testosterone was associated with reduced positive mood after viewing first-graders compared to infants and with more negative mood in all conditions. For fathers, associations between testosterone and mood pointed, albeit not significantly, into the opposite direction. For fathers, high testosterone levels were associated with marginally reduced positive mood after viewing first graders and with descriptively more negative mood in all conditions.

#### 3.2.5. Summary of results for men

In line with our hypotheses, all men reported more liking, caring, and positive mood in response to high baby schema children, independent of child age. Psychophysiological measures, however, were not affected by the baby schema. For men, baby schema effects were independent of parenthood and basal testosterone levels.

In contrast to the baby schema proper, men did not report more liking for infants compared to first-graders and only non-fathers reported more caring. However, both fathers and non-fathers smiled more at infants compared to first graders. This effect was more pronounced for individuals with higher basal testosterone levels. High testosterone levels were also associated with marginally increased liking of all children as well as with less negative mood and more positive mood for non-

**Table 1**  
Summary of Baby Schema and Child Age Effects on All Variables and Their Interactions with Parenthood and Testosterone Levels.

Effects of High Baby Schema (vs. Low Baby Schema)								
	Men				Women			
	Non-Fathers		Fathers		Non-Mothers		Mothers	
	Low T	High T	Low T	High T	Low T	High T	Low T	High T
Liking	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑
Caring	↑	↑	↑	↑	↑↑↑	↑↑↑	↑↑↑	↑↑↑
Smiling								
Sneering					↓↓	(↑)	↓↓	(↑)
SCR					(↑)	(↑)	-	-
Startle								
Positive Mood	↑	↑	↑	↑				
Negative Mood								

Effects of Infant Age (vs. First Grade Age)								
	Men				Women			
	Low T	High T	Low T	High T	Low T	High T	Low T	High T
Liking								
Caring	↑	↑			↑	↑	↑	↑
Smiling	-	↑	-	↑	↑↑↑	-	↑↑↑	-
Sneering								
SCR								
Startle					↑↑↑	↑↑↑		
Positive Mood	↑	-	-	(↑)				
Negative Mood								

Arrows represent effects of condition, i.e. viewing high (vs. low) baby schema images (upper part) or viewing images of infants (vs. first graders; lower part), on stimulus ratings, facial expression responses, skin conductance responses (SCR), acoustic startle reflexes, and mood for non-fathers, fathers, non-mothers, and mothers with low vs. high basal testosterone levels (-/+ SD). Interactions between baby schema and child age have been omitted. Results are based on paired comparisons of estimated marginal means of the respective models. If no interaction of condition with parenthood emerged, paired comparisons were calculated for all men respectively women. If no significant interaction of condition with testosterone emerged, paired comparisons were calculated for all non-fathers, fathers, non-mothers, and mothers respectively. If no significant effect of condition emerged, no paired comparisons were calculated. (↑)=  $p < .10$ , ↑ =  $p < .05$ , ↑↑/↓↓ =  $p < 0.01$ , ↑↑↑ =  $p < 0.001$ .

fathers, but not for fathers. Additionally, for non-fathers, high testosterone levels were also associated with the self-reported desire to become a father.<sup>1</sup> Finally, neither startle responses nor sneering were modulated by baby schema or child age.

### 3.3. Women

#### 3.3.1. Stimulus evaluations

A significant baby schema effect as well as significant baby schema by child age and baby schema by child age by parenthood interactions on liking emerged. Additionally, significant main effects of baby schema and child age on caring emerged.

As Fig. 5 shows, women reported more liking and caring for high baby schema children (liking:  $z = 5.46$ ,  $p < .001$ ; caring:  $z = 7.49$ ,  $p < .001$ ). Mothers reported high liking for all children, but especially for

<sup>1</sup> Non-fathers who want to become fathers had higher testosterone levels ( $Mdn = 61.79$ ) than non-fathers who did not want to become fathers ( $Mdn = 38.99$ , exact Mann-Whitney-U-Test:  $U = 17.00$ ,  $p = .009$ ,  $d = 1.183$ ). For fathers, there was no significant difference in testosterone levels between fathers who wanted more children ( $Mdn = 72.01$ ) and those who did not ( $Mdn = 56.87$ ,  $U = 38.00$ ,  $p = .412$ ,  $d = .398$ ).

high baby schema infants. Additionally, and in contrast to men, all women reported higher caring for infants compared to first graders ( $z = -2.57$ ,  $p = .010$ ).

#### 3.3.2. Facial expression responses

A significant main effect of child age qualified by a significant child age by testosterone interaction on smiling responses emerged. Additionally, there was a significant baby schema by testosterone interaction on sneering.

As Fig. 6a shows, women smiled more at infants compared to first graders and preferential smiling at infants was inversely related to testosterone levels. Analogous to the effects on smiling, reduced sneering at high baby schema children was also inversely related to testosterone levels (see Fig. 6b).

#### 3.3.3. Eye blink startle

A significant main effect of child age qualified by a significant child age by parenthood interaction on startle responses emerged.

Surprisingly, as Fig. 7 shows, non-mothers showed increased startle responses while viewing infants compared to first graders ( $z = -4.43$ ,  $p < .001$ ). Mothers' startle responses, on the other hand, were independent of condition.

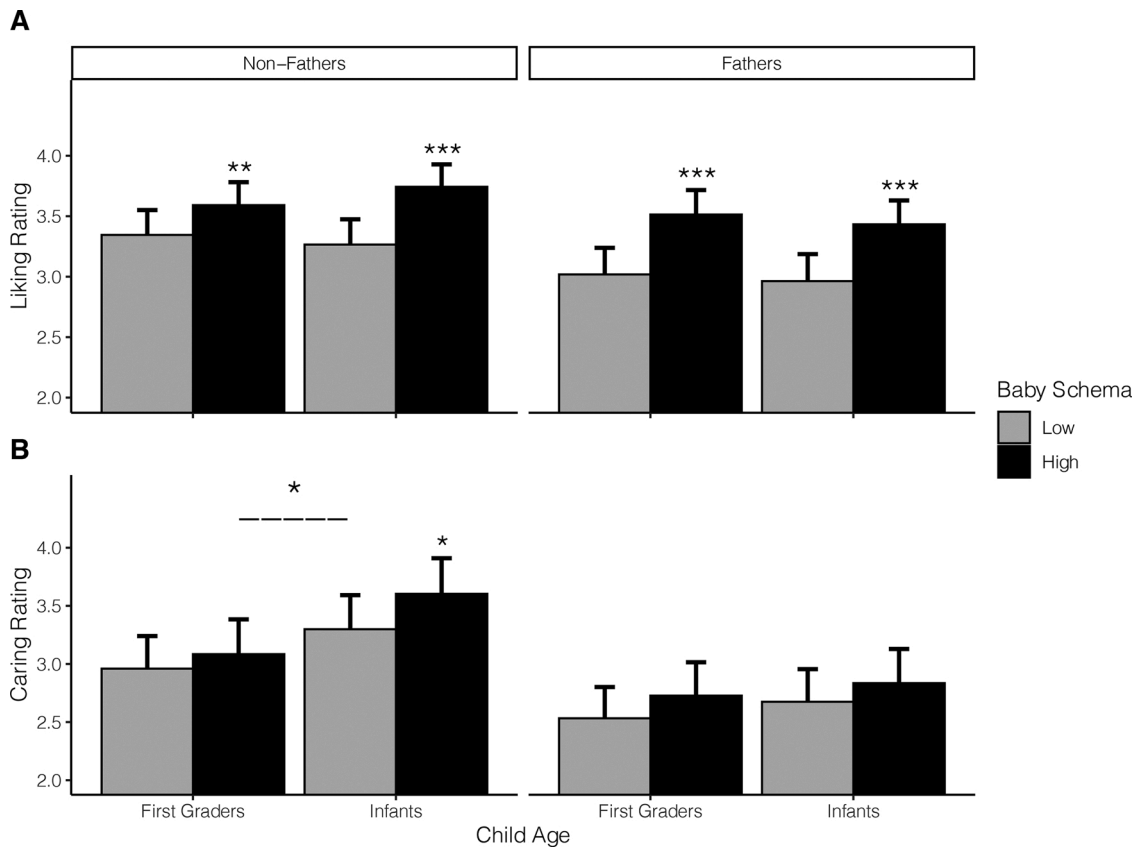


Fig. 3. Estimated marginal means of men’s liking (A) and caring (B) ratings of low and high baby schema infants and first graders, separate for non-fathers and fathers. Error bars represent standard errors. \* $p < .05$ , \*\* $p < .01$ . \*\*\* $p < .001$ .

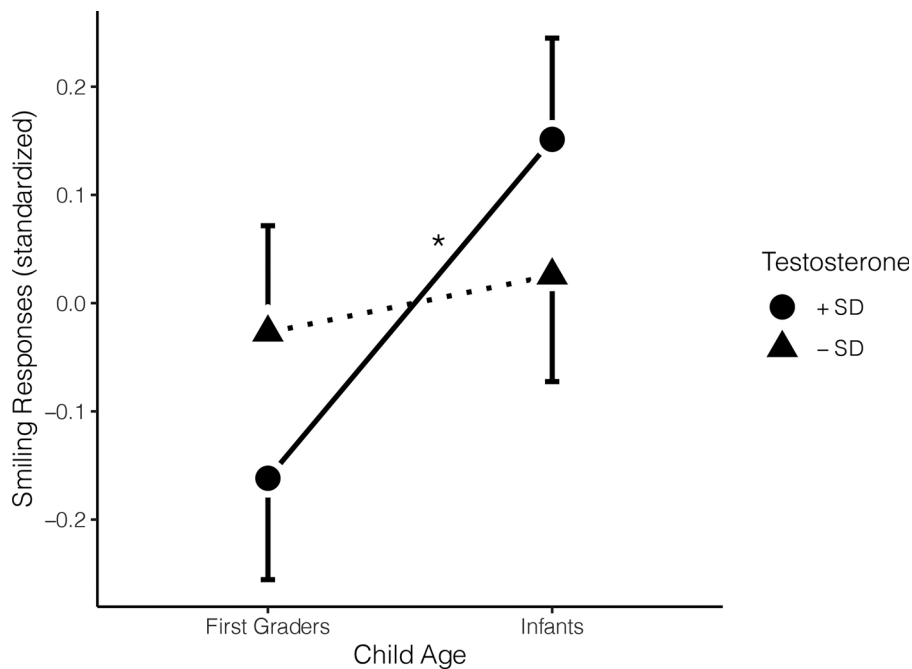


Fig. 4. Estimated marginal means of men’s smiling in response to infants and first graders, separate for men with high and low testosterone levels. Error bars represent standard errors. \* $p < .05$ .

3.3.4. Mood

For all women, lower testosterone levels were associated with increased positive mood in response to high baby schema in infants.

3.3.5. Summary of results for women

Women responded to high baby schema with increased liking, caring, and positive mood just as men did. In contrast to men, women also sneered less at high baby schema children.



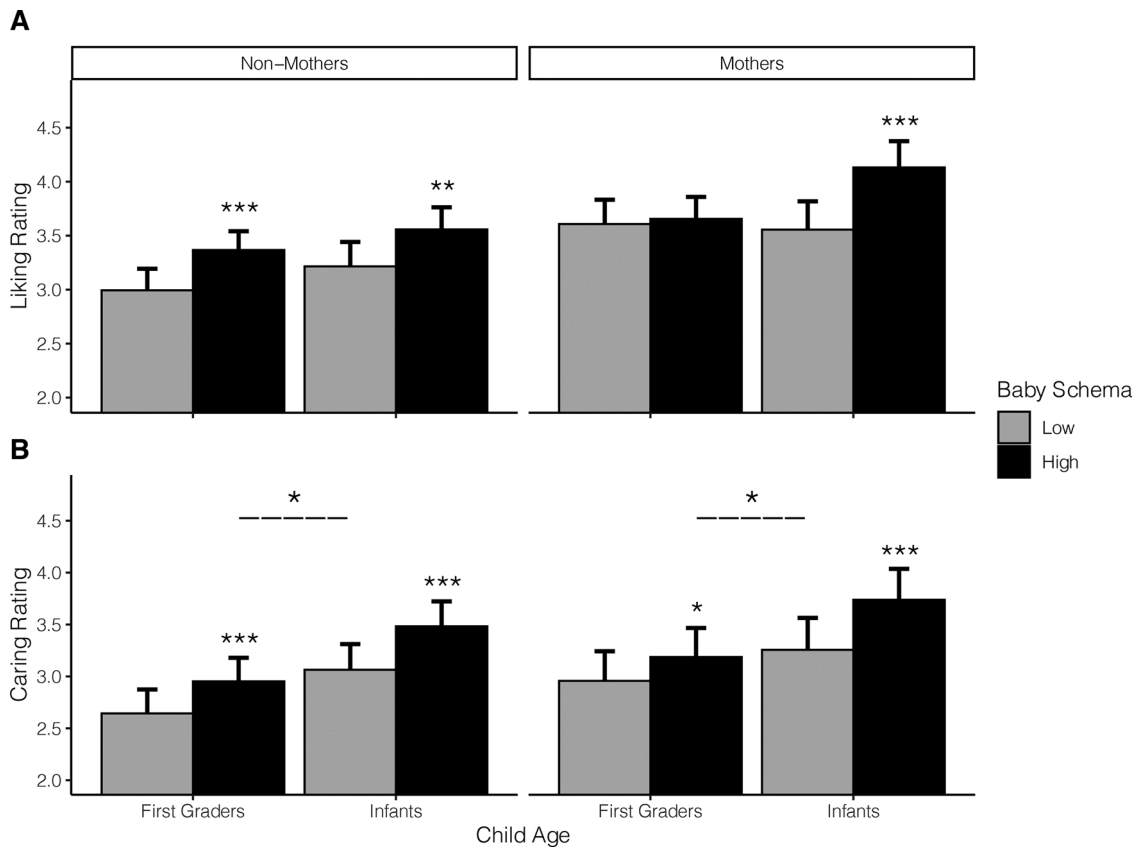


Fig. 5. Estimated marginal means of women’s liking (A) and caring (B) ratings of low and high baby schema infants and first graders, separate for non-mothers and mothers. Error bars represent standard errors. \* $p < .05$ , \*\* $p < .01$ . \*\*\* $p < .001$ .

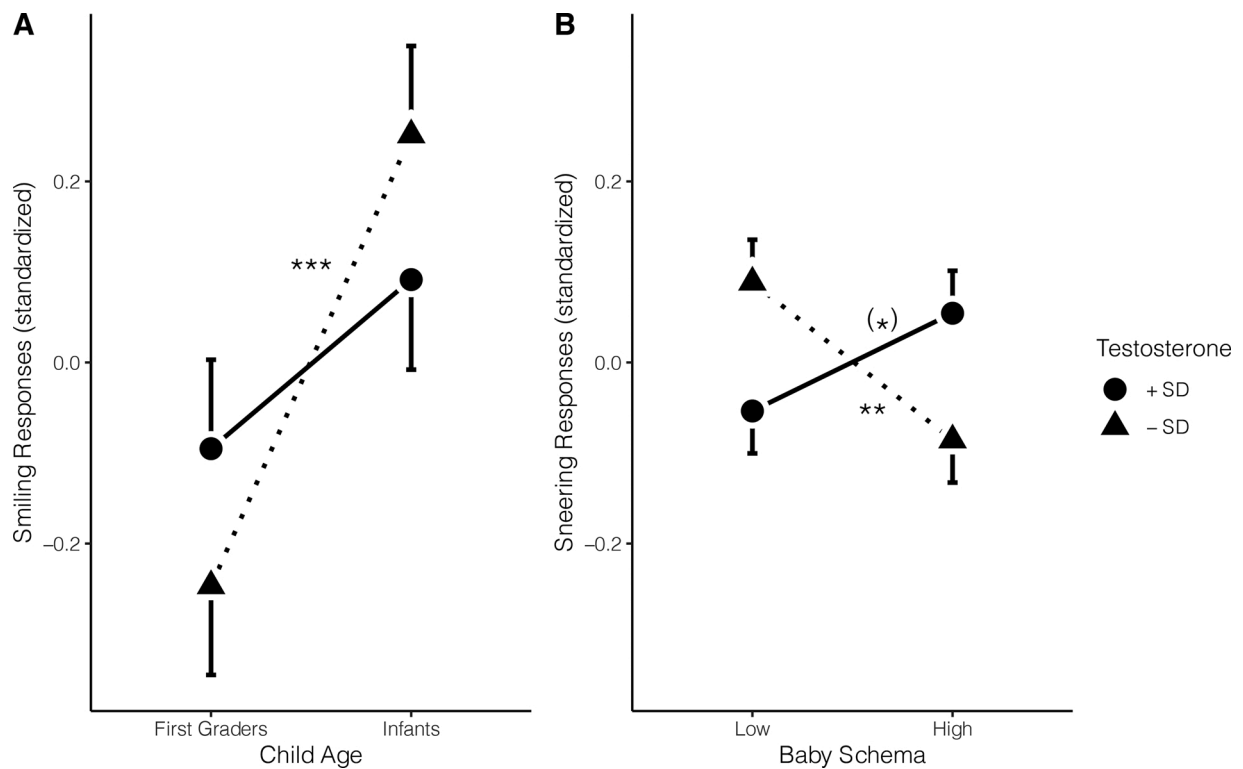


Fig. 6. Estimated marginal means of women’s smiling in response to infants and first graders (A) and women’s sneering in response to low and high baby schema children (B), separate for women with high and low testosterone levels. Error bars represent standard errors. (\*) $p < .10$ , \*\* $p < .01$ , \*\*\* $p < .001$ .

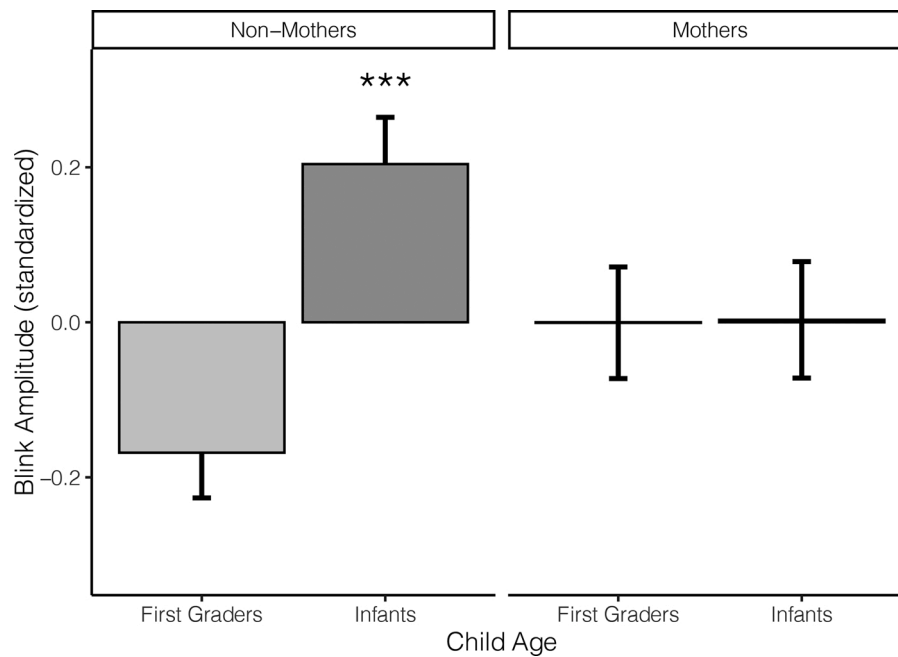


Fig. 7. Estimated marginal means of women's eye-blink startle responses while viewing infants and first graders, separate for non-mothers and mothers. Error bars represent standard errors. \*\*\* $p < .001$ .

In addition to the effects of the baby schema proper, women also differed from men in their responses to infants compared to first graders, independent of specific facial features. These gender differences, however, were small and mostly gradual. For example, women more consistently smiled at infants compared to first graders, and all women reported more caring for infants. One perplexing finding is that non-mothers' startle responses increased significantly while viewing infants compared to first graders.

Finally, for both mothers and non-mothers, lower testosterone levels were associated with more smiling at infants as well as less sneering at high baby schema children.

#### 4. Discussion

The aim of the study was to investigate the effects of the baby schema in infants and first graders on different emotion components in men and women and their association with parenthood and basal testosterone levels. Our study adds to existing literature (e.g., Glocker et al., 2009; Hückstetdt, 1965; Komori & Nittono, 2013) in showing that high baby schema induces liking and caring in both men and women. This fits the notion that the evolutionary function of the baby schema is to protect infants at an age when they become mobile and start to detach from their parents (Eibl-Eibesfeldt, 1989). Thus, it is of prime importance that all potential care takers respond positively and caringly to a helpless child (Hrdy, 2009).

However, whereas all participants responded similarly positively to the baby schema in terms of explicit ratings, we also found interesting interindividual differences. For example, only women responded to the baby schema with modulated expressive behavior (as well as autonomic responses; see supplementary materials). Specifically and as predicted, women sneered less at high baby schema images which indicates reduced rejection or disgust. This result is remarkable, because the cuteness response has been proposed to be antagonistic to disgust (Sherman & Haidt, 2011) – a claim that has not been explicitly studied before. Additionally, both men and women smiled more at infants compared to first graders, but women did so more consistently and also reported more caring for infants. Taken together, our findings on facial expressions replicate previous research that has shown increased

smiling in response to viewing infants compared to other stimuli (e.g., Hildebrandt & Fitzgerald, 1978; Nittono & Ihara, 2017; Spangler et al., 2001), but not in response to more cute or attractive infants (Hildebrandt & Fitzgerald, 1978; Power et al., 1982; Schein & Langlois, 2015). Additionally, our results add to studies that employed a correlational approach and found less sneering at attractive adult and infant faces (Principe & Langlois, 2010; Schein & Langlois, 2015). Whether facial expressive responses in this context are indicative of positive affect or rather of social motivation remains open. We would argue that smiling at an infant primarily serves to signal affiliative intent (Hareli & Hess, 2012). Sneering, on the other hand, is indicative of an affective reaction to unattractiveness as disgust has evolved to be a generalized response to, for example, deformities and other cues of sickness (Rozin, Haidt, & McCauley, 2008) and low baby schema can serve as such a cue (Henderson et al., 2016; Volk et al., 2005). Finally, in terms of sex differences, our results fit the notion of greater female interest in babies (e.g., Maestripieri & Pelka, 2002) and greater female sensitivity to cuteness (Glocker et al., 2009; Lobmaier et al., 2010; Sherman et al., 2012; Sprengelmeyer et al., 2009). This contrasts with other research (Parsons et al., 2011) in which higher female liking ratings were not reflected in viewing times. Thus, more dedicated research is needed to discern sex differences in response to the baby schema, possibly factoring in the moderating role of personality (Hahn, DeBruine, Fisher, 2015; Hahn, DeBruine, 2015; Lehmann et al., 2013; Sherman et al., 2012). In any case, both evolutionary arguments, like the primary caretaker hypothesis (Babchuk, Hames, & Thompson, 1985), as well as social-constructionist theories (Beall, 1993) would hold that women, who have historically been dominantly responsible for child-care (Wood & Eagly, 2002), should experience higher care motivation or show more caring behavior. Whether women's higher caring is a product of evolutionary adaptive pressures or cultural processes, i.e. gendered social expectations on women to be nurturant (Helgeson, 2012; Valiquette-Tessier, Gosselin, Young, & Thomassin, 2019), or a mixture of both remains subject for debate.

In addition to sex, responses to infantile stimuli and the baby schema were also influenced by parenthood and basal testosterone levels. For example, unexpectedly, non-fathers reported significantly higher caring for infants compared to first graders, whereas fathers did not. This

finding could be an artefact of our sample rather than being connected to parenthood per se. As the fathers were slightly older than the non-fathers and their own first children were in the age of our older stimuli, it is possible that they have “outgrown” their general interest in infants and have adapted to caring for older children, which comes with different affordance, e.g. more active play than nurturing. Additionally, testosterone had different effects for fathers and non-fathers, which we will describe in more detail further down. For women the influence of parenthood was more substantial than for men. Whereas all women responded to infants and the baby schema with liking and caring, mothers’ liking ratings as well as their mood were consistently higher for all children and markedly for high baby schema infants. These findings show that for mothers caring and positive affect were consonant.

One additional perplexing finding emerged: Non-mothers responded to infants with both care intentions as well as amplified startle responses. This pattern indicates that non-mothers’ responses to infants are characterized by ambivalence. We would speculate that these ambivalent responses result from normative pressures on women to be nurturant care givers (Helgeson, 2012). In contrast to mothers however, non-mothers lack the first-hand experience with infants. We would argue that viewing infants activates ambivalent expectations of motherhood and care (Porter & Hsu, 2003) leading to negative affect. Thus, having to care for an, even imagined, infant is not only not uniformly positive for non-mothers, but may even be threatening. This negative effect of viewing infants might have been exacerbated by the pairing with the aversive startle probes. Taken together, our findings reflect the consensus in the literature of mothers responding more positive to infantile stimuli than non-mothers (e.g., Feldman & Nash, 1978; Lehmann et al., 2013; Thompson-Booth et al., 2014a; Weisman et al., 2012).

Finally, we found sex-dependent associations of salivary testosterone levels with reactions to our stimuli. In line with previous research (e.g., Hahn, DeBruine, Fisher, 2015; Hahn, DeBruine, 2015), basal testosterone levels were not associated with explicit stimulus ratings of liking and caring. We did, however, find sex-dependent associations of testosterone with mood and physiological measures. For both mothers and non-mothers, lower testosterone levels were associated with less sneering at high baby schema children as well as with more smiling at infants. Taken together, these findings add to previous research that show lower responsiveness to babies in general to be associated with higher testosterone levels in women (e.g., Holtfrerich et al., 2018). Further, they present the first evidence of high testosterone to also be associated with reduced responsiveness to baby schema variations in children. On a more general level, previous research showed an association of high testosterone with reduced empathy in women, for example in terms of facial mimicry (Hermans, Putman, & van Honk, 2006). High testosterone in women was also associated with reduced automatic attention to fearful faces (e.g., Van Honk, Peper, & Schutter, 2005), which are not only morphologically similar to high baby schema faces (Marsh, Adams, & Kleck, 2005), but also conceptually: Both, fearful expressions and infantile facial features, serve as cues for vulnerability and elicit protective tendencies (Blair, 1995; Dijkers, 2014; Schenkel, 1967).

Taken together, our results suggest that testosterone reduces positive emotional responding to the baby schema in women, in line with the notion of testosterone being antagonistic to nurturing and pro-social behavior in women. However, in contrast to our findings, testosterone administration has also been shown to upregulate maternal care, possibly through conversion to estradiol (e.g., Bos et al., 2010). Additionally, in a longitudinal design, high levels of naturally varying testosterone were also found to increase the reward value of cute infants faces (Hahn, DeBruine, Fisher, 2015; Hahn, DeBruine, 2015). Thus, the role of testosterone for maternal care is complex and warrants further investigation, particularly taking into account natural fluctuations and variability (Endendijk et al., 2016) as well as the interactions with other hormones like estradiol and oxytocin (e.g., Liening & Josephs, 2010; Van Anders, Goldey, & Kuo, 2011).

In contrast to women, testosterone did not influence men’s responsiveness to the baby schema. Other testosterone effects for men were more ambiguous than for women and depended on fatherhood. Overall, for fathers, high testosterone seemed to counter caregiving, as would be expected from the literature (for a review see Gettler, 2020). High testosterone levels were associated with decreased liking for all children as well as with reduced positive mood and more negative facial expressions in response to first graders. This reduced responsiveness to first graders is especially relevant, because the mean age of the fathers’ actual own first children is the same as for our stimuli. These results are in line with previous research showing that paternal caregiving is inversely related to testosterone levels (e.g., Kuo et al., 2018; Kuo, Carp, Light, & Grewen, 2012; Mascaro et al., 2013) and lend further support to the challenge hypothesis which posits that testosterone mediated a trade-off between mating efforts and paternal care (Gray et al., 2019; Wingfield et al., 1990).

For non-fathers, in contrast to fathers and women, higher testosterone was consistently associated with increased responsiveness to all children in terms of liking, and mood, as well as with more smiling at infants. Testosterone levels were also associated with the self-reported desire to become a father. Whereas on the surface, these results seem to contradict the notion of current theories about the association between testosterone and nurturing behavior, we suggest a different interpretation. A more nuanced reading of extant research on testosterone and care (e.g., Van Anders, 2013) shows that testosterone can indeed be facilitative of care involving protection. Testosterone is supposed to ready the organism for a challenge. We would argue that the combination of children and startle probes signals a potential “challenge” and thus increases care in non-fathers with high testosterone levels in terms of social signaling (i.e., smiling) and vigilance (Setoh & Esposito, 2019). Whereas fathers experience in their daily lives that children primarily need nurturing, not defending, non-fathers’ reactions are less educated. From an evolutionary perspective, it is plausible that the role of non-fathers, who don’t have own children to nurture, is to defend all the children of the tribe. Thus, it is plausible that basal testosterone in a startling environment is associated with globally increased liking and vigilance. Additionally, the trade-off between mating and nurturing efforts hypothesized by the challenge-theory is virtually nonexistent for non-fathers. Thus, care intentions might actually serve as mating signals to further reproductive goals (Cashdan, 1993; Jensen, 2013) instead of being in opposition. As for women, effects of men’s testosterone on caretaking in general warrant further research, considering different kinds of care, the role of intra-individual variability and hormonal reactivity as well as the complex interactions with other hormones. However, in regard to men’s responsiveness to the baby schema proper, testosterone does not seem to play a substantial role.

One important methodological finding concerns the use of age as an equivalent for the baby schema (e.g., Lehmann et al., 2013). In our study, child age effects deviated from baby schema effects for several variables (e.g., in terms of liking, caring, mood, and psychophysiological measures). Thus, we argue that age is not a good proxy for baby schema effects. Future research should differentiate between responses to the baby schema, i.e. specific infantile facial features, and responses to infants as a stimulus class. Still, comparing reactions to babies and older children or adults can surface interesting insights into human caregiving and general responsiveness to infants.

## 5. Limitations and suggestions for future research

Despite offering a valuable addition to extant research on the baby schema as well as the influence of testosterone and parenthood on responses to infants, our study has limitations and generated new research questions. First, our stimuli depicted only two age groups, infants and first graders. We made this choice because the prime interest of our study was the baby schema proper and not age effects. However, future

research might use multiple age groups, from infants to young adults, or even systematically vary the age of targets using modern graphics software to further elucidate the differential effects baby schema has depending on target age.

Second, we used stimuli that showed both infants and older children with mostly neutral, i.e. unsmiling faces. This was done to avoid adding an emotion induction procedure when photographing infants. Yet, it is plausible that social expectations regarding socially adequate behavior extend to first graders. That is, that adults – and especially women – expect first grader to smile when photographed as this is the socially expected behavior (Hess, Beaupré, & Cheung, 2002). This may have elicited more negative reactions towards these children. Further, overlaps and interactions exist between morphological features, like baby-facedness or facial dominance, and emotional expressions (Hess, Adams, & Kleck, 2009; Marsh et al., 2005) and smiling expressions in children makes them appear more cute (Almanza-Sepúlveda et al., 2018). Thus, including stimuli of different valence and intensity would allow to disambiguate baby-schema effects from the effects of social expectations, and further our understanding of potential effects of baby-facedness on adults' empathic reactions to children's emotions.

More importantly, our results on testosterone effects are limited by their static and correlational nature. Future research should elucidate acute effects of testosterone by experimentally administering testosterone in addition to measuring it (Bos, Panksepp, Bluthé, & Honk, 2012) and by studying testosterone reactivity and intra-individual changes in testosterone (e.g., Endendijk et al., 2016; Geniole & Carré, 2018; Van Anders & Watson, 2006a; Zilioli & Bird, 2017) in addition to baseline levels. Furthermore, multiple hormones other than testosterone have been associated with parental behavior (for reviews see Bridges, 2008; Numan & Insel, 2003), most prominently, in recent years, oxytocin (e.g., Feldman & Bakermans-Kranenburg, 2017; Galbally, Lewis, Ijzendoorn, & Permezel, 2011). One possibly fruitful approach would be to take several hormonal measures into account as well as their interactions (e.g., Edelstein et al., 2015; Gordon, Pratt, Bergunde, Zagory-Sharon, & Feldman, 2017; Van Anders et al., 2011).

Finally, because men and women, as to be expected, had very different testosterone distributions, we decided to analyze them separately. However, this means that we could not compare men's and women's reactions directly.

## 6. Conclusion

In summary, our study shows that the baby schema leads to positive affective responses and care intentions in all adults. The scope of these responses and the processes underlying them, however, depend on gender, parenthood and hormonal status. Women responded more strongly, also on a physiological level, to babies and the baby schema than men. But not all women responded uniformly positively to babies. Whereas mothers' positive affectivity and care were in line with each other, non-mothers' responses were much more ambivalent, characterized by tenderness, care and negative affect at the same time. And, whereas fathers' interest in babies was shaped by positive affectivity, non-fathers' interest might be jointly driven by care and readiness to meet a challenge. Thus, whereas everybody agrees that the baby schema is cute, and cuteness is pleasant, responses to babies as a whole are much less uniform.

## Author contributions

F. Löwenbrück developed the research question. All authors contributed to the study design. Testing and data collection were performed by F. Löwenbrück. F. Löwenbrück performed the data analysis and interpretation under the supervision of U. Hess. F. Löwenbrück drafted the manuscript, and U. Hess provided critical revisions. All authors approved the final version of the manuscript for submission. The research was supported by a doctoral scholarship by Evangelisches

Studienwerk Villigst to the first author. This research was conducted in the framework of the doctoral thesis of the first author.

## Declaration of Competing Interest

The authors declare no conflict of interests.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.biopsycho.2021.108120>.

## References

- Alley, T. R., Alley, P., Hilde, K., Mark, L., Sachs, B., & Shaw, R. (1981). Head shape and the perception of cuteness. *Developmental Psychology*, 17(5), 650–654. <https://doi.org/10.1037/0012-1649.17.5.650>
- Almanza-Sepúlveda, M. L., Dudin, A., Wonch, K. E., Steiner, M., Feinberg, D. R., Fleming, A. S., & Hall, G. B. (2018). Exploring the morphological and emotional correlates of infant cuteness. *Infant Behavior and Development*, 53, 90–100. <https://doi.org/10.1016/j.infbeh.2018.08.001>
- Archer, J., & Monton, S. (2011). Preferences for infant facial features in pet dogs and cats. *Ethology*, 117(3), 217–226. <https://doi.org/10.1111/j.1439-0310.2010.01863.x>
- Baayen, R. H., Davidson, R. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, 59(4), 390–412. <https://doi.org/10.1016/j.jml.2007.12.005>
- Babchuk, W. A., Hames, R. B., & Thompson, R. A. (1985). Sex differences in the recognition of infant facial expressions of emotion: The primary caretaker hypothesis. *Ethology and Sociobiology*, 6(2), 89–101. [https://doi.org/10.1016/0162-3095\(85\)90002-0](https://doi.org/10.1016/0162-3095(85)90002-0)
- Barr, D. J. (2013). Random effects structure for testing interactions in linear mixed-effects models. *Frontiers in Psychology*, 4, 328. <https://doi.org/10.3389/fpsyg.2013.00328>
- Barrett, J., & Fleming, A. S. (2011). All mothers are not created equal: Neural and psychobiological perspectives on mothering and the importance of individual differences. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, 52(4), 368–397. <https://doi.org/10.1111/j.1469-7610.2010.02306.x>
- Barrett, E. S., Tran, V., Thurston, S., Jasienska, G., Furberg, A.-S., Ellison, P. T., & Thune, I. (2013). Marriage and motherhood are associated with lower testosterone concentrations in women. *Hormones and Behavior*, 63(1), 72–79. <https://doi.org/10.1016/j.yhbeh.2012.10.012>
- Bates, D., Kliegl, R., Vasishth, S., & Baayen, H. (2015). *Parsimonious mixed models*. Available from arXiv:1506.04967 (stat.ME) <http://arxiv.org/abs/1506.04967>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Baucom, D. H., Besch, P. K., & Callahan, S. (1985). Relation between testosterone concentration, sex role identity, and personality among females. *Journal of Personality and Social Psychology*, 48(5), 1218–1226. <https://doi.org/10.1037/0022-3514.48.5.1218>
- Beall, A. E. (1993). A social constructionist view of gender. In A. E. Beall, & R. J. Sternberg (Eds.), *The psychology of gender* (pp. 127–147). New York: Guilford Press.
- Benning, S. D. (2018). The postauricular reflex as a measure of attention and positive emotion. *Oxford handbooks online*. <https://doi.org/10.1093/oxfordhb/9780199935291.013.74>
- Benning, S. D., Patrick, C. J., & Lang, A. R. (2004). Emotional modulation of the post-auricular reflex. *Psychophysiology*, 41(3), 426–432. <https://doi.org/10.1111/j.1469-8986.00160.x>
- Berman, P. W. (1980). Are women more responsive than men to the young? A review of developmental and situational variables. *Psychological Bulletin*, 88(3), 668–695. <https://doi.org/10.1037/0033-2909.88.3.668>
- Blair, R. J. R. (1995). A cognitive developmental approach to morality: Investigating the psychopath. *Cognition*, 57(1), 1–29. [https://doi.org/10.1016/0010-0277\(95\)00676-P](https://doi.org/10.1016/0010-0277(95)00676-P)
- Bloch, S., Orthous, P., & Santibanez-H, G. (1987). Effector patterns of basic emotions: A psychophysiological method for training actors. *Journal of Social and Biological Systems*, 10(1), 1–19. [https://doi.org/10.1016/0140-1750\(87\)90031-5](https://doi.org/10.1016/0140-1750(87)90031-5)
- Blumenthal, T. D., Cuthbert, B. N., Filion, D. L., Hackley, S., Lipp, O. V., & Van Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology*, 42(1), 1–15. <https://doi.org/10.1111/j.1469-8986.2005.00271.x>
- Borgi, M., Cogliati-Dezza, I., Brelsford, V., Meints, K., & Cirulli, F. (2014). Baby schema in human and animal faces induces cuteness perception and gaze allocation in children. *Frontiers in Psychology*, 5, 411. <https://doi.org/10.3389/fpsyg.2014.00411>
- Bos, P. A. (2017). The endocrinology of human caregiving and its intergenerational transmission. *Development and Psychopathology*, 29(3), 971–999. <https://doi.org/10.1017/S0954579416000973>
- Bos, P. A., Hermans, E. J., Montoya, E. R., Ramsey, N. F., & van Honk, J. (2010). Testosterone administration modulates neural responses to crying infants in young

- females. *Psychoneuroendocrinology*, 35(1), 114–121. <https://doi.org/10.1016/j.psyneuen.2009.09.013>
- Bos, P. A., Panksepp, J., Bluthé, R.-M., & Honk, J. van (2012). Acute effects of steroid hormones and neuropeptides on human social–Emotional behavior: A review of single administration studies. *Frontiers in Neuroendocrinology*, 33(1), 17–35. <https://doi.org/10.1016/j.yfrne.2011.01.002>
- Boucsein, W. (2012). *Electrodermal activity*. Boston: Springer. <https://doi.org/10.1007/978-1-4614-1126-0>
- Bridges, R. S. (2008). *Neurobiology of the parental brain*. Cambridge: Academic Press. <https://doi.org/10.1016/B978-0-12-374285-8.X0001-7>
- Cashdan, E. (1993). Attracting mates: Effects of paternal investment on mate attraction strategies. *Ethology and Sociobiology*, 14(1), 1–23. [https://doi.org/10.1016/0162-3095\(93\)90014-9](https://doi.org/10.1016/0162-3095(93)90014-9)
- Castro, A., & McDonald, K. (2011). *FaceSubstitutionEditor*. *GitHub-Repository*. Retrieved from <https://github.com/cyphunk/FaceSubstitutionEditor>.
- Collova, J. R., Sutherland, C. A. M., & Rhodes, G. (2019). Testing the functional basis of first impressions: Dimensions for children's faces are not the same as for adults' faces. *Journal of Personality and Social Psychology*, 117(5), 900–924. <https://doi.org/10.1037/pspa0000167>
- Deag, J. M., & Crook, J. H. (1971). Social behaviour and 'agonistic buffering' in the wild barbary macaque *Macaca sylvana* L. *Folia Primatologica*, 15(3–4), 183–200. <https://doi.org/10.1159/000155378>
- Dijkster, A. J. M. (2014). A theory of vulnerability-based morality. *Emotion Review*, 6(2), 175–183. <https://doi.org/10.1177/1754073913514120>
- Duarte-Guterman, P., Leuner, B., & Galea, L. A. M. (2019). The long and short term effects of motherhood on the brain. *Frontiers in Neuroendocrinology*, 53, Article 100740. <https://doi.org/10.1016/j.yfrne.2019.02.004>
- Dudin, A., Wonch, K. E., Davis, A. D., Steiner, M., Fleming, A. S., & Hall, G. B. (2019). Amygdala and affective responses to infant pictures: Comparing depressed and non-depressed mothers and non-mothers. *Journal of Neuroendocrinology*, 31(9), Article e12790. <https://doi.org/10.1111/jne.12790>
- Edelstein, R. S., Wardecker, B. M., Chopik, W. J., Moors, A. C., Shipman, E. L., & Lin, N. J. (2015). Prenatal hormones in first-time expectant parents: Longitudinal changes and within-couple correlations. *American Journal of Human Biology*, 27(3), 317–325. <https://doi.org/10.1002/ajhb.22670>
- Eibl-Eibesfeldt, I. (1989). *Human ethology*. New York: de Gruyter.
- Eisenberg, N., Gershoff, E. T., Fabes, R. A., Shepard, S. A., Cumberland, A. J., Losoya, S. H., ... Murphy, B. C. (2001). Mother's emotional expressivity and children's behavior problems and social competence: Mediation through children's regulation. *Developmental Psychology*, 37(4), 475–490. <https://doi.org/10.1037/0012-1649.37.4.475>
- Endendijk, J. J., Hallers-Haalboom, E. T., Groeneveld, M. G., van Berckel, S. R., van der Pol, L. D., Bakermans-Kranenburg, M. J., & Mesman, J. (2016). Diurnal testosterone variability is differentially associated with parenting quality in mothers and fathers. *Hormones and Behavior*, 80, 68–75. <https://doi.org/10.1016/j.yhbeh.2016.01.016>
- Esposito, G., Nakazawa, J., Ogawa, S., Stival, R., Kawashima, A., Putnick, D. L., & Bornstein, M. H. (2014). Baby, you light-up my face: Culture-general physiological responses to infants and culture-specific cognitive judgements of adults. *PLoS One*, 9(10), Article e106705. <https://doi.org/10.1371/journal.pone.0106705>
- Feldman, R., & Bakermans-Kranenburg, M. J. (2017). Oxytocin: A parenting hormone. *Current Opinion in Psychology*, 15(17), 13–18. <https://doi.org/10.1016/j.copsyc.2017.02.011>
- Feldman, S. S., & Nash, S. C. (1978). Interest in babies during young adulthood. *Child Development*, 49(3), 617–622. <https://doi.org/10.2307/1128228>
- Feldman, R., Braun, K., & Champagne, F. A. (2019). The neural mechanisms and consequences of paternal caregiving. *Nature Reviews Neuroscience*, 20(4), 205–224. <https://doi.org/10.1038/s41583-019-0124-6>
- Fleming, A. S., Corter, C., Stallings, J., & Steiner, M. (2002). Testosterone and prolactin are associated with emotional responses to infant cries in new fathers. *Hormones and Behavior*, 42(4), 399–413. <https://doi.org/10.1006/hbeh.2002.1840>
- Fox, J. (1991). *Regression diagnostics*. Newbury Park: Sage Publications.
- Franklin, P., & Volk, A. A. (2018). A review of infants' and children's facial cues' influence on adults' perceptions and behaviors. *Evolutionary Behavioral Sciences*, 12(4), 296–321. <https://doi.org/10.1037/ebbs0000108>
- Fridlund, A. J., & MacDonald, M. (1998). Approaches to goldie: A field study of human approach responses to canine juvenescence. *Anthrozoos*, 11(2), 95–100. <https://doi.org/10.2752/089279398787000751>
- Frith, C. D., & Allen, H. A. (1983). The skin conductance orienting response as an index of attention. *Biological Psychology*, 17(1), 27–39. [https://doi.org/10.1016/0301-0511\(83\)90064-9](https://doi.org/10.1016/0301-0511(83)90064-9)
- Galbally, M., Lewis, A. J., Ijzendoorn, M. V. an, & Permezel, M. (2011). The role of oxytocin in mother-infant relations: A systematic review of human studies. *Harvard Review of Psychiatry*, 19(1), 1–14. <https://doi.org/10.3109/10673229.2011.549771>
- Geniole, S. N., & Carré, J. M. (2018). Human social neuroendocrinology: Review of the rapid effects of testosterone. *Hormones and Behavior*, 104, 192–205. <https://doi.org/10.1016/j.yhbeh.2018.06.001>
- Gettler, L. T. (2020). Exploring evolutionary perspectives on human fatherhood and paternal biology: Testosterone as an exemplar. In H. E. Fitzgerald, K. von Klitzing, N. Cabrera, J. Scarano de Mendonça, & T. Skjøthaug (Eds.), *Handbook of fathers and child development* (pp. 137–152). Cham: Springer International Publishing.
- Gettler, L. T., Lew-Levy, S., Sarma, M. S., Miegakanda, V., & Boyette, A. H. (2020). Sharing and caring: Testosterone, fathering, and generosity among BaYaka foragers of the Congo Basin. *Scientific Reports*, 10(1), 15422. <https://doi.org/10.1038/s41598-020-70958-3>
- Glocker, M. L., Langleben, D. D., Ruparel, K., Loughead, J. W., Gur, R. C., & Sachser, N. (2009). Baby schema in infant faces induces cuteness perception and motivation for caretaking in adults. *Ethology*, 115(3), 257–263. <https://doi.org/10.1111/j.1439-0310.2008.01603.x>
- Golle, J., Lisibach, S., Mast, F. W., & Lobmaier, J. S. (2013). Sweet puppies and cute babies: Perceptual adaptation to babyfacedness transfers across species. *PLoS ONE*, 8(3), Article e58248. <https://doi.org/10.1371/journal.pone.0058248>
- Golle, J., Probst, F., Mast, F. W., & Lobmaier, J. S. (2015). Preference for cute infants does not depend on their ethnicity or species: Evidence from hypothetical adoption and donation paradigms. *PLoS One*, 10(4), Article e0121554. <https://doi.org/10.1371/journal.pone.0121554>
- Gordon, I., Pratt, M., Bergunde, K., Zagoory-Sharon, O., & Feldman, R. (2017). Testosterone, oxytocin, and the development of human parental care. *Hormones and Behavior*, 93, 184–192. <https://doi.org/10.1016/j.yhbeh.2017.05.016>
- Gould, S. J. (1979). Mickey Mouse meets Konrad Lorenz. *Natural History*, 88(5), 30–36.
- Granger, D. A., Shirtcliff, E. A., Booth, A., Kivlighan, K. T., & Schwartz, E. B. (2004). The “trouble” with salivary testosterone. *Psychoneuroendocrinology*, 29(10), 1229–1240. <https://doi.org/10.1016/j.psyneuen.2004.02.005>
- Gray, P. B., McHale, T. S., & Carré, J. M. (2015). A review of human male field studies of hormones and behavioral reproductive effort. *Hormones and Behavior*, 91, 52–67. <https://doi.org/10.1016/j.yhbeh.2016.07.004>
- Gray, P. B., Straffis, A. A., Bird, B. M., McHale, T. S., & Zilioli, S. (2019). Human reproductive behavior, life history, and the Challenge Hypothesis: A 30-year review, retrospective and future directions. *Hormones and Behavior*, 123, 104530. <https://doi.org/10.1016/j.yhbeh.2019.04.017>
- Grebe, N. M., Sarafin, R. E., Strenth, C. R., & Zilioli, S. (2019). Pair-bonding, fatherhood, and the role of testosterone: A meta-analytic review. *Neuroscience and Biobehavioral Reviews*, 98, 221–233. <https://doi.org/10.1016/j.neubiorev.2019.01.010>
- Hahn, A. C., DeBruine, L. M., Fisher, C. I., & Jones, B. C. (2015). The reward value of infant facial cuteness tracks within-subject changes in women's salivary testosterone. *Hormones and Behavior*, 67, 54–59. <https://doi.org/10.1016/j.yhbeh.2014.11.010>
- Hahn, A. C., DeBruine, L. M., & Jones, B. C. (2015). Reported maternal tendencies predict the reward value of infant facial cuteness, but not cuteness detection. *Biology Letters*, 11(3), Article 20140978. <https://doi.org/10.1098/rsbl.2014.0978>
- Hahn, A. C., & Perrett, D. I. (2014). Neural and behavioral responses to attractiveness in adult and infant faces. *Neuroscience and Biobehavioral Reviews*, 46(4), 591–603. <https://doi.org/10.1016/j.neubiorev.2014.08.015>
- Hahn, A. C., Xiao, D., Sprengelmeyer, R., & Perrett, D. I. (2013). Gender differences in the incentive salience of adult and infant faces. *The Quarterly Journal of Experimental Psychology*, 66(1), 200–208. <https://doi.org/10.1080/17470218.2012.705860>
- Harelil, S., & Hess, U. (2012). The social signal value of emotions. *Cognition & Emotion*, 26(3), 385–389. <https://doi.org/10.1080/02699931.2012.665029>
- Helgeson, V. S. (2012). *The psychology of gender*. Boston: Pearson.
- Henderson, A. J., Holzelitner, I. J., Talamas, S. N., & Perrett, D. I. (2016). Perception of health from facial cues. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371, Article 20150380. <https://doi.org/10.1098/rstb.2015.0380>
- Hermans, E. J., Putman, P., & van Honk, J. (2006). Testosterone administration reduces empathic behavior: A facial mimicry study. *Psychoneuroendocrinology*, 31(7), 859–866. <https://doi.org/10.1016/j.psyneuen.2006.04.002>
- Hess, U., Adams, R. B. J., & Kleck, R. E. (2004). Facial appearance, gender, and emotion expression. *Emotion*, 4(4), 378–388. <https://doi.org/10.1037/1528-3542.4.4.378>
- Hess, U., Adams, R. B., & Kleck, R. E. (2009). The face is not an empty canvas: How facial expressions interact with facial appearance. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1535), 3497–3504. <https://doi.org/10.1098/rstb.2009.0165>
- Hess, U., Arslan, R., Mauersberger, H., Blaison, C., Dufner, M., Denissen, J. J. A., & Ziegler, M. (2017). Reliability of surface facial electromyography. *Psychophysiology*, 54(1), 12–23. <https://doi.org/10.1111/psyp.12676>
- Hess, U., Beaupré, M. G., & Cheung, N. (2002). Who to whom and why – Cultural differences and similarities in the function of smiles. In M. Abel, & C. H. Ceia (Eds.), *An empirical reflection on the smile* (Vol. 4, pp. 187–216). New York: Edwin Mellen Press.
- Hildebrandt, K. A., & Fitzgerald, H. E. (1978). Adults' responses to infants varying in perceived cuteness. *Behavioural Processes*, 3(2), 159–172. [https://doi.org/10.1016/0376-6357\(78\)90042-6](https://doi.org/10.1016/0376-6357(78)90042-6)
- Holtfrerich, S. K. C., Pfister, R., Gammal, A. T. El, Bellon, E., & Diekhof, E. K. (2018). Endogenous testosterone and exogenous oxytocin influence the response to baby schema in the female brain. *Scientific Reports*, 8, 7672. <https://doi.org/10.1038/s41598-018-26020-4>
- Hrdy, S. B. (2005). Evolutionary context of human development: The cooperative breeding model. In C. S. Carter, L. Ahnert, K. E. Grossmann, S. B. Hrdy, M. E. Lamb, S. W. Porges, & N. Sachser (Eds.), *Attachment and bonding: A New synthesis* (pp. 9–32). Cambridge: MIT Press. <https://doi.org/10.1093/acprof:oso/9780195320510.003.0003>
- Hrdy, S. B. (2009). Allomotherhood across species, across cultures, and through time. In G. R. Bentley, & R. Mace (Eds.), *Substitute parents: Biological and social perspectives on alloparenting in human societies* (pp. xi–xviii). New York: Berghahn Books.
- Hückstedt, B. (1965). Experimentelle Untersuchungen zum “Kinchenschema.” [Experimental investigations on the “baby schema”]. *Zeitschrift Für Experimentelle Und Angewandte Psychologie*, 12(3), 421–450.
- Janke, W., Hüppe, M., & Erdmann, G. (2002). *Befindlichkeitskalierung anhand von Kategorien und Eigenschaftswörtern (BSKE) [Mood checklist based on categories and adjectives]*. Würzburg/Lübeck/Berlin: Department for Biological and Clinical Psychology.
- Jensen, N. H. (2013). Male mating signaling in social dilemma Games. *Journal of Evolutionary Psychology*, 11(3), 131–150. <https://doi.org/10.1556/jep.11.2013.3.3>

- Judd, C. M., Westfall, J., & Kenny, D. A. (2017). Experiments with more than one random factor: Designs, analytic models, and statistical power. *Annual Review of Psychology, 68*(1), 601–625. <https://doi.org/10.1146/annurev-psych-122414-033702>
- Komori, M., & Nittono, H. (2013). Influence of age-independent facial traits on adult judgments of cuteness and infantility of a child's face. *Procedia - Social and Behavioral Sciences, 97*, 285–291. <https://doi.org/10.1016/j.sbspro.2013.10.235>
- Kringelbach, M. L., Stark, E. A., Alexander, C., Bornstein, M. H., & Stein, A. (2016). On cuteness: Unlocking the parental brain and beyond. *Trends in Cognitive Sciences, 20* (7), 545–558. <https://doi.org/10.1016/j.tics.2016.05.003>
- Kuo, P. X., Braungart-Rieker, J. M., Burke Lefever, J. E., Sarma, M. S., O'Neill, M., & Gettler, L. T. (2018). Fathers' cortisol and testosterone in the days around infants' births predict later paternal involvement. *Hormones and Behavior, 106*, 28–34. <https://doi.org/10.1016/j.yhbeh.2018.08.011>
- Kuo, P. X., Carp, J., Light, K. C., & Grewen, K. M. (2012). Neural responses to infants linked with behavioral interactions and testosterone in fathers. *Biological Psychology, 91*(2), 302–306. <https://doi.org/10.1016/j.biopsycho.2012.08.002>
- Kuzawa, C. W., Gettler, L. T., Huang, Y. Y., & McDade, T. W. (2010). Mothers have lower testosterone than non-mothers: Evidence from the Philippines. *Hormones and Behavior, 57*(4–5), 441–447. <https://doi.org/10.1016/j.yhbeh.2010.01.014>
- Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30*(3), 261–273. <https://doi.org/10.1111/j.1469-8986.1993.tb03352.x>
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review, 97*(3), 377–395. <https://doi.org/10.1037/0033-295X.97.3.377>
- Lehmann, V., Huis in't Veld, E. M. J., & Vingerhoets, A. J. J. M. (2013). The human and animal baby schema effect: Correlates of individual differences. *Behavioural Processes, 94*, 99–108. <https://doi.org/10.1016/j.beproc.2013.01.001>
- Lenth, R. (2017). *Emmeans: Estimated marginal means, aka least-squares means*. R-Package. Leuner, B., Glasper, E. R., & Gould, E. (2010). Parenting and plasticity. *Trends in Neurosciences, 33*(10), 465–473. <https://doi.org/10.1016/j.tins.2010.07.003>
- Liening, S. H., & Josephs, R. A. (2010). It is not just about testosterone: Physiological mediators and moderators of testosterone's behavioral effects. *Social and Personality Psychology Compass, 4*(11), 982–994. <https://doi.org/10.1111/j.1751-9004.2010.00316.x>
- Lishner, D. A., Batson, C. D., & Huss, E. (2011). Tenderness and sympathy: Distinct empathic emotions elicited by different forms of need. *Personality and Social Psychology Bulletin, 37*(5), 614–625. <https://doi.org/10.1177/0146167211403157>
- Little, A. C. (2012). Manipulation of infant-like traits affects perceived cuteness of infant, adult and cat faces. *Ethology, 118*(8), 775–782. <https://doi.org/10.1111/j.1439-0310.2012.02068.x>
- Lobmaier, J. S., Probst, F., Perrett, D. L., & Heinrichs, M. (2015). Menstrual cycle phase affects discrimination of infant cuteness. *Hormones and Behavior, 70*, 1–6. <https://doi.org/10.1016/j.yhbeh.2015.02.001>
- Lobmaier, J. S., Sprengelmeyer, R., Wiffen, B., & Perrett, D. I. (2010). Female and male responses to cuteness, age and emotion in infant faces. *Evolution and Human Behavior, 31*(1), 16–21. <https://doi.org/10.1016/j.evolhumbehav.2009.05.004>
- LoBue, V., & Thrasher, C. (2015). The Child Affective Facial Expression (CAFE) set: Validity and reliability from untrained adults. *Frontiers in Psychology, 5*, 1532. <https://doi.org/10.3389/fpsyg.2014.01532>
- Lorenz, K. (1935). Der Kumpan in der Umwelt des Vogels [The mate in the bird's environment]. *Journal für Ornithologie, 83*(3), 289–413. <https://doi.org/10.1007/BF01905572>
- Lorenz, K. (1943). Die angeborenen Formen möglicher Erfahrung [The innate forms of possible experience]. *Zeitschrift Für Tierpsychologie, 5*(2), 235–409. <https://doi.org/10.1111/j.1439-0310.1943.tb00655.x>
- Lucion, M. K., Oliveira, V., Bizarro, L., Bischhoff, A. R., Silveira, P. P., & Kauer-Sant'Anna, M. (2017). Attentional bias toward infant faces—Review of the adaptive and clinical relevance. *International Journal of Psychophysiology, 114*, 1–8. <https://doi.org/10.1016/j.ijpsycho.2017.01.008>
- Luo, L., Ma, X., Zheng, X., Zhao, W., Xu, L., Becker, B., & Kendrick, K. M. (2015). Neural systems and hormones mediating attraction to infant and child faces. *Frontiers in Psychology, 6*, 970. <https://doi.org/10.3389/fpsyg.2015.00970>
- Maestripieri, D., & Pelka, S. (2002). Sex differences in interest in infants across the lifespan. *Human Nature, 13*(3), 327–344. <https://doi.org/10.1007/s12110-002-1018-1>
- Maier, R. A., Holmes, D. L., Slaymaker, F. L., & Reich, J. N. (1984). The perceived attractiveness of preterm infants. *Infant Behavior and Development, 7*(4), 403–414. [https://doi.org/10.1016/S0163-6383\(84\)80002-8](https://doi.org/10.1016/S0163-6383(84)80002-8)
- Marler, C. A., Bester-Meredith, J. K., & Trainor, B. C. (2003). Paternal behavior and aggression: Endocrine mechanisms and nongenomic transmission of behavior. *Advances in the Study of Behavior, 32*, 263–323. [https://doi.org/10.1016/S0065-3454\(03\)01006-4](https://doi.org/10.1016/S0065-3454(03)01006-4)
- Marsh, A. A., Adams, R. B., & Kleck, R. E. (2005). Why do fear and anger look the way they do? Form and social function in facial expressions. *Personality and Social Psychology Bulletin, 31*(1), 73–86. <https://doi.org/10.1177/0146167204271306>
- Mascaro, J. S., Hackett, P. D., & Rilling, J. K. (2013). Testicular volume is inversely correlated with nurturing-related brain activity in human fathers. *Proceedings of the National Academy of Sciences, 110*(39), 15746–15751. <https://doi.org/10.1073/pnas.1305579110>
- Mascaro, J. S., Hackett, P. D., & Rilling, J. K. (2014). Differential neural responses to child and sexual stimuli in human fathers and non-fathers and their hormonal correlates. *Psychoneuroendocrinology, 46*(6), 153–163. <https://doi.org/10.1016/j.psyneuen.2014.04.014>
- Matuschek, H., Kliegl, R., Vasishth, S., Baayen, H., & Bates, D. (2017). Balancing Type I error and power in linear mixed models. *Journal of Memory and Language, 94*, 305–315. <https://doi.org/10.1016/j.jml.2017.01.001>
- McKelvie, S. J. S. (1993). Perceived cuteness, activity level, and gender in schematic babyfaces. *Journal of Social Behavior and Personality, 8*(2), 297. <https://doi.org/10.1017/CBO9781107415324.004>
- Meijer, W. M., Ijzendoorn, M. H. V. an, & Bakermans, M. J. (2019). Challenging the challenge hypothesis on testosterone in fathers: Limited meta-analytic support. *Psychoneuroendocrinology, 110*, Article 104435. <https://doi.org/10.1016/j.psyneuen.2019.104435>
- Miesler, L., Leder, H., & Herrmann, A. (2011). Isn't it cute: An evolutionary perspective of baby-schema effects in visual product designs. *International Journal of Design, 5*(3), 17–30.
- Morris, P. H. H., Reddy, V., & Bunting, R. C. C. (1995). The survival of the cutest: who's responsible for the evolution of the teddy bear? *Animal Behaviour, 50*(6), 1697–1700. [https://doi.org/10.1016/0003-3472\(95\)80022-0](https://doi.org/10.1016/0003-3472(95)80022-0)
- Nash, S. C., & Feldman, S. S. (1980). Responsiveness to babies: Life-situation specific sex differences in adulthood. *Sex Roles, 6*(5), 751–758. <https://doi.org/10.1007/BF00287495>
- Nicely, P., Tamis-LeMonda, C. S., & Bornstein, M. H. (1999). Mothers' attuned responses to infant affect expressivity promote earlier achievement of language milestones. *Infant Behavior and Development, 22*(4), 557–568. [https://doi.org/10.1016/S0163-6383\(00\)00023-0](https://doi.org/10.1016/S0163-6383(00)00023-0)
- Niedenthal, P. M., & Brauer, M. (2012). Social functionality of human emotion. *Annual Review of Psychology, 63*, 259–285. <https://doi.org/10.1146/annurev-psych.121208.131605>
- Nieuwenhuis, R., Te Grotenhuis, M., & Pelzer, B. (2012). Influence.ME: Tools for detecting influential data in mixed effects models. *R Journal, 4*(2), 38–47.
- Nittono, H. (2016). The two-layer model of 'kawaii': A behavioural science framework for understanding kawaii and cuteness. *East Asian Journal of Popular Culture, 2*(1), 79–95. <https://doi.org/10.1386/eapc.2.1.79.1>
- Nittono, H., & Ihara, N. (2017). Psychophysiological responses to kawaii pictures with or without baby schema. *SAGE Open, 7*(2), 1–2. <https://doi.org/10.1177/2158244017709321>
- Numan, M., & Insel, T. R. (2003). *The neurobiology of parental behavior*. New York: Springer. <https://doi.org/10.1007/b97533>
- O'Neil, M. J., Danvers, A. F., & Shiota, M. N. (2018). Nurturant love and caregiving emotions. In H. C. Lench (Ed.), *The function of emotions* (Vol. 33, pp. 175–193). Springer International Publishing. [https://doi.org/10.1007/978-3-319-77619-4\\_9](https://doi.org/10.1007/978-3-319-77619-4_9)
- Oliveira, V., Goulart, M., Nobre, J. C., Lucion, M. K., Silveira, P. P., & Bizarro, L. (2017). Emotional interference of baby and adult faces on automatic attention in parenthood. *Psychology & Neuroscience, 10*(2), 144–153. <https://doi.org/10.1037/pne0000085>
- Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotions*. New York: Oxford University Press.
- Parsons, C. E., Young, K. S., Kumari, N., Stein, A., & Kringelbach, M. L. (2011). The motivational salience of infant faces is similar for men and women. *PLoS ONE, 6*(5), Article e20632. <https://doi.org/10.1371/journal.pone.0020632>
- Porter, C. L., & Hsu, H. C. (2003). First-time mothers' perceptions of efficacy during the transition to motherhood: Links to infant temperament. *Journal of Family Psychology, 17*(1), 54–64. <https://doi.org/10.1037/0893-3200.17.1.54>
- Power, T. G., Hildebrandt, K. A., & Fitzgerald, H. E. (1982). Adults' responses to infants varying in facial expression and perceived attractiveness. *Infant Behavior and Development, 5*(1), 33–44. [https://doi.org/10.1016/S0163-6383\(82\)80015-5](https://doi.org/10.1016/S0163-6383(82)80015-5)
- Principe, C. P., & Langlois, J. H. (2010). Faces differing in attractiveness elicit corresponding affective responses. *Cognition, 114*, 140–148. [https://doi.org/10.1016/S0262-1008\(09\)00361-2](https://doi.org/10.1016/S0262-1008(09)00361-2)
- R Core Team. (2019). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.
- Rajhans, P., Goin-Kochel, R. P., Strathearn, L., & Kim, S. (2019). It takes two! Exploring sex differences in parenting neurobiology and behaviour. *Journal of Neuroendocrinology, 31*(9), Article e12721. <https://doi.org/10.1111/jne.12721>
- Rilling, J. K. (2013). The neural and hormonal bases of human parental care. *Neuropsychologia, 51*(4), 731–747. <https://doi.org/10.1016/j.neuropsychologia.2012.12.017>
- Rilling, J. K., & Mascaró, J. S. (2017). The neurobiology of fatherhood. *Current Opinion in Psychology, 15*, 26–32. <https://doi.org/10.1016/j.copsyc.2017.02.013>
- Roelke, E., Raiss, M., King, S., Lytel-Sternberg, J., & Zeifman, D. M. (2019). Infant crying levels elicit divergent testosterone response in men. *Parenting, 19*(1–2), 39–55. <https://doi.org/10.1080/15295192.2019.1555425>
- Rozin, P., Haidt, J., & McCauley, C. R. (2008). Disgust. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (pp. 757–776). Guilford Press.
- Sanefuji, W., Ohgami, H., & Hashiya, K. (2007). Development of preference for baby faces across species in humans (Homo sapiens). *Journal of Ethology, 25*(3), 249–254. <https://doi.org/10.1007/s10164-006-0018-8>
- Schein, S. S., & Langlois, J. H. (2015). Unattractive infant faces elicit negative affect from adults. *Infant Behavior and Development, 38*, 130–134. <https://doi.org/10.1016/j.infbeh.2014.12.009>
- Schenkel, R. (1967). Submission: Its features and function in the wolf and dog. *American Zoologist, 7*(2), 319–329. <https://doi.org/10.1093/icb/7.2.319>
- Schleidt, M., Schiefelhövel, W., Stanjek, K., & Krell, R. (1980). "Caring for a baby" behavior: Reactions of passersby to a mother and baby. *Man-Environment Systems, 10* (2), 73–82.
- Senese, V. P., De Falco, S., Bornstein, M. H., Caria, A., Buffolino, S., & Venuti, P. (2013). Human infant faces provoke implicit positive affective responses in parents and non-

- parents alike. *PLoS ONE*, 8(11), Article e80379. <https://doi.org/10.1371/journal.pone.0080379>
- Setoh, P., & Esposito, G. (2019). What men do when a baby cries: Increasing testosterone may lead to less nurturant care but more environmental vigilance. *Parenting*, 19(1–2), 62–64. <https://doi.org/10.1080/15295192.2019.1555428>
- Sherman, G. D., & Haidt, J. (2011). Cuteness and disgust: The humanizing and dehumanizing effects of emotion. *Emotion Review*, 3(3), 245–251. <https://doi.org/10.1177/1754073911402396>
- Sherman, G. D., Haidt, J., & Coan, J. A. (2009). Viewing cute images increases behavioral carefulness. *Emotion*, 9(2), 282. <https://doi.org/10.1037/a0014904>
- Sherman, G. D., Haidt, J., Iyer, R., & Coan, J. A. (2012). Individual differences in the physical embodiment of care: Prosocially oriented women respond to cuteness by becoming more physically careful. *Emotion*, 13(1), 151–158. <https://doi.org/10.1037/a0029259>
- Shiota, M. N., Campos, B., Oveis, C., Hertenstein, M. J., Simon-Thomas, E., & Keltner, D. (2017). Beyond happiness: Building a science of discrete positive emotions. *American Psychologist*, 72(7), 617–643. <https://doi.org/10.1037/a0040456>
- Shiota, M. N., Neufeld, S. L., Yeung, W. H., Moser, S. E., & Perea, E. F. (2011). Feeling good: Autonomic nervous system responding in five positive emotions. *Emotion*, 11(6), 1368–1378. <https://doi.org/10.1037/a0024278>
- Spangler, G., Emlinger, S., Meinhardt, J., & Hamm, A. (2001). The specificity of infant emotional expression for emotion perception. *International Journal of Psychophysiology*, 41(2), 155–168. [https://doi.org/10.1016/S0167-8760\(01\)00127-1](https://doi.org/10.1016/S0167-8760(01)00127-1)
- Sprengelmeyer, R., Lewis, J., Hahn, A., & Perrett, D. I. (2013). Aesthetic and incentive salience of cute infant faces: Studies of observer sex, oral contraception and menstrual cycle. *PLoS ONE*, 8(5), Article e65844. <https://doi.org/10.1371/journal.pone.0065844>
- Sprengelmeyer, R., Perrett, D. I., Fagan, E. C., Cornwell, R. E., Lobmaier, J. S., Sprengelmeyer, A., ... Young, A. W. (2009). The cutest little baby face: A hormonal link to sensitivity to cuteness in infant faces. *Psychological Science*, 20(2), 149–154. <https://doi.org/10.1111/j.1467-9280.2009.02272.x>
- Stavropoulos, K. K. M., & Alba, L. A. (2018). “It’s so cute I could crush it!”: Understanding neural mechanisms of cute aggression. *Frontiers in Behavioral Neuroscience*, 12, Article 300. <https://doi.org/10.3389/fnbeh.2018.00300>
- Sternglanz, S. H., Gray, J. L., & Murakami, M. (1977). Adult preferences for infantile facial features: An ethological approach. *Animal Behaviour*, 25(Part 1), 108–115. [https://doi.org/10.1016/0003-3472\(77\)90072-0](https://doi.org/10.1016/0003-3472(77)90072-0)
- Storey, A. E., Noseworthy, D. E., Delahunty, K. M., Halfyard, S. J., & McKay, D. W. (2011). The effects of social context on the hormonal and behavioral responsiveness of human fathers. *Hormones and Behavior*, 60(4), 353–361. <https://doi.org/10.1016/j.yhbeh.2011.07.001>
- Storey, A. E., & Ziegler, T. E. (2015). Primate paternal care: Interactions between biology and social experience. *Hormones and Behavior*, 77, 260–271. <https://doi.org/10.1016/j.yhbeh.2015.07.024>
- Thompson-Booth, C., Viding, E., Mayes, L. C., Rutherford, H. J. V., Hodsoll, S., & McCrory, E. J. (2014a). Here’s looking at you, kid: Attention to infant emotional faces in mothers and non-mothers. *Developmental Science*, 17(1), 35–46. <https://doi.org/10.1111/desc.12090>
- Thompson-Booth, C., Viding, E., Mayes, L. C., Rutherford, H. J. V., Hodsoll, S., & McCrory, E. (2014b). I can’t take my eyes off of you: Attentional allocation to infant, child, adolescent and adult faces in mothers and non-mothers. *Plos One*, 9(10), e109362. <https://doi.org/10.1371/journal.pone.0109362>
- Traxel, W. (1960). Die Möglichkeit einer objektiven Messung der Stärke von Gefühlen [The possibility of an objective measurement of the intensity of feelings]. *Psychologische Forschung*, 26, 75–90. <https://doi.org/10.1007/BF00421616>
- Udry, J. R. (2000). Biological limits of gender construction. *American Sociological Review*, 65(3), 443–457. <https://doi.org/10.2307/2657466>
- Udry, J. R., Morris, N. M., & Kovenock, J. (1995). Androgen effects on women’s gendered behaviour. *Journal of Biosocial Science*, 27(3), 359–368. <https://doi.org/10.1017/s0021932000022884>
- Valiquette-Tessier, S. C., Gosselin, J., Young, M., & Thomassin, K. (2019). A literature review of cultural stereotypes associated with motherhood and fatherhood. *Marriage and Family Review*, 55(4), 299–329. <https://doi.org/10.1080/01494929.2018.1469567>
- Van Anders, S. M. (2013). Beyond masculinity: Testosterone, gender/sex, and human social behavior in a comparative context. *Frontiers in Neuroendocrinology*, 34(3), 198–210. <https://doi.org/10.1016/j.yfrne.2013.07.001>
- Van Anders, S. M., & Goldey, K. L. (2010). Testosterone and partnering are linked via relationship status for women and “relationship orientation” for men. *Hormones and Behavior*, 58(5), 820–826. <https://doi.org/10.1016/j.yhbeh.2010.08.005>
- Van Anders, S. M., & Watson, N. V. (2006a). Social neuroendocrinology. *Human Nature*, 17(2), 212–237. <https://doi.org/10.1007/s12110-006-1018-7>
- Van Anders, S. M., & Watson, N. V. (2006b). Relationship status and testosterone in North American heterosexual and non-heterosexual men and women: Cross-sectional and longitudinal data. *Psychoneuroendocrinology*, 31(6), 715–723. <https://doi.org/10.1016/j.psyneuen.2006.01.008>
- Van Anders, S. M., Goldey, K. L., & Kuo, P. X. (2011). The Steroid/Peptide Theory of Social Bonds: Integrating testosterone and peptide responses for classifying social behavioral contexts. *Psychoneuroendocrinology*, 36(9), 1265–1275. <https://doi.org/10.1016/j.psyneuen.2011.06.001>
- Van Anders, S. M., Tolman, R. M., & Volling, B. L. (2012). Baby cries and nurturance affect testosterone in men. *Hormones and Behavior*, 61(1), 31–36. <https://doi.org/10.1016/j.yhbeh.2011.09.012>
- Van Honk, J., Peper, J. S., & Schutter, D. J. L. G. (2005). Testosterone reduces unconscious fear but not consciously experienced anxiety: Implications for the disorders of fear and anxiety. *Biological Psychiatry*, 58(3), 218–225. <https://doi.org/10.1016/j.biopsych.2005.04.003>
- Volk, A. A., Lukjanczuk, J. M., & Quinsey, V. L. (2005). Influence of infant and child facial cues of low body weight on adults’ ratings of adoption preference, cuteness, and health. *Infant Mental Health Journal*, 26(5), 459–469. <https://doi.org/10.1002/imhj.20064>
- Voorthuis, A., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2017). Testosterone reactivity to infant crying and caregiving in women: The role of oral contraceptives and basal cortisol. *Infant Behavior and Development*, 56, Article 101191. <https://doi.org/10.1016/j.infbeh.2017.08.002>
- Vrana, S. R. (1993). The psychophysiology of disgust: Differentiating negative emotional contexts with facial EMG. *Psychophysiology*, 30(3), 279–286. <https://doi.org/10.1111/j.1469-8986.1993.tb03354.x>
- Vrana, S. R., Spence, E. L., & Lang, P. J. (1988). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology*, 97, 487–491.
- Weisman, O., Feldman, R., & Goldstein, A. (2012). Parental and romantic attachment shape brain processing of infant cues. *Biological Psychology*, 89(3), 533–538. <https://doi.org/10.1016/j.biopsycho.2011.11.008>
- Weisman, O., Zagory-Sharon, O., & Feldman, R. (2014). Oxytocin administration, salivary testosterone, and father-infant social behavior. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 49, 47–52. <https://doi.org/10.1016/j.pnpbp.2013.11.006>
- Whitehouse, A. J. O., Gilani, S. Z., Shafait, F., Mian, A., Tan, D. W., Maybery, M. T., ... Eastwood, P. (2015). Prenatal testosterone exposure is related to sexually dimorphic facial morphology in adulthood. *Proceedings of the Royal Society B: Biological Sciences*, 282(1816), Article 20151351. <https://doi.org/10.1098/rspb.2015.1351>
- Wingfield, J. C., Hegner, R. E., Dufty, A. M., & Ball, G. F. (1990). The “challenge hypothesis”: Theoretical implications for patterns of testosterone secretion, mating systems, and breeding strategies. *The American Naturalist*, 136(6), 829–846. <https://doi.org/10.1086/285134>
- Wood, W., & Eagly, A. H. (2002). A cross-cultural analysis of the behavior of women and men: Implications for the origins of sex differences. *Psychological Bulletin*, 128(5), 699–727. <https://doi.org/10.1037/0033-2909.128.5.699>
- Zebrowitz, L. A. (1997). *Reading faces: Window to the soul?* Boulder, Colorado: Westview Press.
- Zebrowitz, L. A. (2003). Overgeneralization effects in perceiving nonverbal behavior: Evolutionary and ecological origins. *Journal of Nonverbal Behavior*, 27(2), 133–138. <https://doi.org/10.1023/A:10239665266601>
- Zebrowitz, L. A. (2006). Finally, faces find favor. *Social Cognition*, 24(5), 657–701. <https://doi.org/10.1521/soco.2006.24.5.657>
- Zebrowitz, L. A., & Montepare, J. M. (1992). Impressions of babyfaced individuals across the life span. *Developmental Psychology*, 28(6), 1143–1152. <https://doi.org/10.1037/0012-1649.28.6.1143>
- Zhou, Q., Eisenberg, N., Losoya, S. H., Fabes, R. A., Reiser, M., Guthrie, I. K., ... Shepard, S. A. (2002). The relations of parental warmth and positive expressiveness to children’s empathy-related responding and social functioning: A longitudinal study. *Child Development*, 73(3), 893–915. <https://doi.org/10.1111/1467-8624.00446>
- Zilioli, S., & Bird, B. M. (2017). Functional significance of men’s testosterone reactivity to social stimuli. *Frontiers in Neuroendocrinology*, 47, 1–18. <https://doi.org/10.1016/j.yfrne.2017.06.002>
- Zilkha, N., Scott, N., & Kimchi, T. (2017). Sexual dimorphism of parental care: From genes to behavior. *Annual Review of Neuroscience*, 40, 273–305. <https://doi.org/10.1146/annurev-neuro-072116-031447>